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VEGETABLE CROPS FOR MARKET AND PROCESSING

VEGETABLE CROPS FOR MARKET AND PROCESSING

by

A. H. HOARE
Ministry of Agriculture and Fisheries
Author of Commercial Apple Growing, Fruit Culture, etc.

Third Edition
(Revised and Enlarged)

FOREWORD

H. V. TAYLOR, C.B.E., D.SC., V.M.H. A.R.C.S.

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Foreword to the Second Edition

By H. V. TAYLOR, O.B.E., D.Sc., V.M.H., A.R.C.S.

This book is concerned with the industry engaged in producing vegetables for sale and quite rightly contains a chapter picturing the large size of the industry, its rapid development during the war period and its continued and future expansion. Other chapters are technical, containing valuable information as to the varieties to choose for sale, their method of production, harvesting and treatment prior to sale.

One of the important things within the present decade noticed by keen observers has been the rise in importance of vegetables in the daily dietary of the people and their recognition as essential foods by the highest medical authorities. Governments bent on health improvement now urge a greater consumption of these. Vegetables are essential foods. No wonder then that the industry expands yearly and that growers lay plans for an increased production and look forward to an enhanced trade.

This is a bright picture but there is another side, for the public yearly become more discriminating in what they buy, so that the good vegetables only are taken and the inferior left, whilst the medical profession stress more and more the need for selecting varieties richest in vitamin contents. The vegetable grower of the future, then, must become more and more a master of his craft and sufficiently knowledgeable to keep his productions in close harmony with the needs of the public. His varieties must be acceptable, his cultural methods good, his crops clean, well graded and packed. To such men this book should be of great assistance for the grower is told

the best kinds to grow, of their production and marketing. It is surprising indeed to be able to get so much knowledge at so little expense.

Just at present, too, there is some prejudice against eating vegetables produced on land receiving only artificial fertilizers and they are thought by some to be less beneficial to health than vegetables grown on soil fertilized with natural manures.

In time science will decide whether this prejudice is justified or not. The main point, however, for the vegetable grower to realise is that his soils must be kept fertile and always well supplied with humus, minerals, lime and water.

A fertile soil is one that is healthy, abundant in living organisms and containing sufficient plant food and minerals to promote healthy growth. Every soil under crops gradually becomes more and more acid and should have occasional applications of lime to neutralise the acid and keep the soil at the correct level. The soil, too, must constantly receive decaying vegetable matter to encourage a large population of worms, bacteria, yeasts and other organisations that break down vegetation into humus—the essential substance that makes soil spongy so that it will absorb water when plentiful and retain it for the use of plants during periods of drought. All vegetables, too, should contain numerous minerals, and if there is insufficient the vegetables are not perfect—so the grower must constantly replace any lost minerals and so prevent any shortage in the soil.

This story of soil fertility is well and simply told in this book and none need hesitate to follow this advice. The excellent illustrations impress one with business aspects of vegetable growing and the thorough way in which the operations have to be completed. This is a book full of sound knowledge, a book that could well become a book of reference for growers—both small and large—of "commercial" vegetables, and the gain would be theirs.

H. V. TAYLOR

Potters Bar,
1944.

Preface to the Second Edition

The decision of the publishers to issue a second edition of this book, which for some time has been unobtainable, provided an opportunity of revising the text so as to bring the work into line with the advance of knowledge. For in common with all sections of agriculture and horticulture, the business of vegetable crop production has continued to benefit from an increase of knowledge derived from research and experimental stations and from practical work in the field. This valuable work is always going on.

Since this book was written notable advances have been made with the development of useful machinery suitable for vegetable crops, with the control of weeds, pests and diseases by the use of suitable sprays and with the development of compost making to meet the scarcity of farmyard and stable manure. More is now known, too, about the value of cultivations, particularly their effect on soil moisture.

As was the case during the war period of 1914-18 the present war has demonstrated the importance of an adequate supply of vegetables in the daily dietary of the people. While the fresh vegetable market has always been an important one in Great Britain it is of interest to note that the development of such processes as canning, freezing and dehydration while providing the public with additional sources of supply has at the same time opened up new markets for the vegetable grower. Thus this particular type of crop husbandry would appear to possess excellent prospects for the future.

A.H.H.

March, 1944.

Preface to the Third Edition

The second printing of the second edition having been quickly exhausted, the publishers suggested that a revised and enlarged third edition should be prepared to meet the demand that evidently exists for a book of this kind.

Originally written to conform to a planned size, and on lines necessarily brief, the book has now been enlarged to nearly twice its former size. In order to render the work as comprehensive and useful as possible, fresh material dealing with the production of special crops for processing (pickling, drying and canning) has been included. Information on the dehydration and quick-freezing of vegetables has also been added. Three entirely new chapters have been written. One dealing with the national status of the vegetable-growing industry and the important role played by it in the nation's life aims at being generally informative. Another on the subject of tuber crops is devoted mainly to the potato, a subject originally omitted and now, by general request, included. The third additional chapter deals with pests and diseases of vegetable crops and their control. All the old material has been carefully revised to bring it into line with the latest knowledge.

I am indebted to Mr. F. A. Secrett for the photograph of one of his vegetable farms, to Chase Protected Cultivation Ltd., for the two photographs of cloche cultivation, to Sigmund Pumps Ltd. for the photograph of the rotary rainers, and to Messrs. C. P. Kinnell and Co. Ltd. for the illustration of the sprayline irrigation system.

A.H.H.

June, 1947.

Contents

		Page
	Foreword to second edition	5
	Preface to second edition	7
	Preface to third edition	9
	List of illustrations	13

PART ONE—**The general subject.**

Chapter		
I	**The status of the vegetable growing industry**	17
II	**A Survey of Production** . . . . . Old methods and the new—Extensive cultivation by farmers—Intensive production on market-garden lines—Systems of distribution—Markets—Economics—Areas of production—Statistics.	26
III	**Soil, Climate, Manuring, Tillage** . . . . . Soils for vegetable production—Influence of climate—Irrigation—Composting—The principles of manurial treatment—Tillage systems—Mechanized production.	47
IV	**The Crop Plant** . . . . . The importance of seed in relation to crop production—Varieties—Modern plant-breeding methods—Diseases that are seed-borne—Seed sowing—Plant raising and transplanting.	86

PART TWO—**The Cultivated Crops.**

V	**The Cabbage Crops** . . . . . Brussels Sprouts, Broccoli, Cauliflowers, Cabbage, Kale, Red Cabbage, Sprouting Broccoli, Growing Seed of the Cabbage crops.	112
VI	**Leguminous Crops** . . . . . Green Peas, Peas for Canning, Dried Peas, Runner Beans, French or Kidney Beans, Broad Beans.	141

Chapter *Page*

VII **Root Crops** 160
Carrots, Turnips and Swedes, Parsnips, Red Beet, Salsify, Coffee Chicory.

VIII **Tuber Crops** 178
Potatoes, Artichokes (Jerusalem).

IX **Bulb Crops** 187
Onions, Leeks, Shallots, Garlic.

X **Salad Crops** 200
Lettuce (outdoor), Tomatoes (outdoor), Watercress, Green Onions, Mustard and Cress, Ridge Cucumbers, Gherkins, Chicory, Endive, Radishes.

XI **Miscellaneous Crops** 220
Asparagus, Globe Artichokes, Rhubarb, Vegetable Marrows, Spinach (various), Mushrooms, Sweet Corn.

XII **Early and Forced Crops** 249
Glasshouses—Dutch Frame culture—Heated frames—French frames—The Evesham hand-light—Cloches—Forced vegetables (Rhubarb, Seakale, Witloof Chicory—Mint—French Beans, Vegetable Marrows).

XIII **Culinary Herbs** 273
Parsley, Mint, Sage, Horse-radish, Thyme, Caraway.

XIV **Pests and Diseases of Vegetable Crops Insecticides and Fungicides** 281

Appendix

I **Grading and Packing—Principal Containers for Market Produce** 309

II **Fertilizers for the Vegetable Grower** . . . 313

III **Finance and Accounts** 319

IV **Standard list of vegetables** 330

Literature 329

Index 333

List of Illustrations

Fig.		Facing Page
1.	Caterpillar tractor cultivating Boulder Clay	*facing* 40
2.	*Lanz* track laying tractor drawing three-furrow plough	40
3.	General View of a modern vegetable farm	*between* pp. 40 & 41
4.	Tillage with a *Fordson* tractor—combined operations	*between* 40 & 41
5.	Applying the fertilizer	*between* 40 & 41
6.	Hand planting with dibbers	41
7.	The mechnical transplanter at work	41
8.	Hoeing a field of parsnips by " crawling "	48
9.	A small *Planet* hoe	48
10.	Smallest motor-driven-hoe—the *Auto-Culto*	49
11.	*Farmall* tractor and cultivator at work in a field of cabbage	49
12.	A plant breeder at work	64
13.	Cage in which plants are grown for seed in complete isolation	64
14.	An improved type of Brussels sprout	65
15.	" Lenten Monarch " broccoli	65
16.	Italian type cauliflower, " Majestic " (*Clucas*)	72
17.	Ormskirk savoy cabbage	72
18.	A field of spring cabbage	*between* 72 & 73
19.	Four examples of English peas grown for market	*between* 72 & 73
20.	Examples of English peas grown for market	*between* 72 & 73
21.	Examples of Longpod type of Broad bean	*between* 72 & 73
22.	A potato planting machine at work	73
23.	A field of onion seed	73
24.	Cabbage lettuce, the *Trocadero* type, Clucas's " Borough Wonder "	128
25.	Packing lettuce for market in the field	128

Fig.		Facing Page
26.	Hand-hoeing a field of early lettuce	*between* 128/9
27.	Forking over asparagus beds in March	*between* 128/9
28.	Grading asparagus	*between* 128/9
29.	Bundling asparagus	*between* 128/9
30.	Packed crates of asparagus ready for dispatch	129
31.	Popular type of market celery, " Market White " or " Curly White "	129
32.	Raising seedlings of celery under double Dutch lights	144
33.	Pricking out celery seedlings	144
34.	Unit of frames for raising plants	*between* 144/5
35.	Raising early cauliflower plants in frames	*between* 144/5
36.	Transplanting tomatoes by machine	*between* 144/5
37.	Outdoor tomato cultivation. General view of field	*between* 144/5
38.	Outdoor mushroom beds covered with straw and hessian for protection	145
39.	Indoor mushroom beds in full production	145
40.	Evesham hand-lights	160
41.	Dutch lights	160
42.	The Continuous Cloche. The strip or panel system of cropping	161
43.	The Continuous Cloche. The strip or panel system of cropping	161
44.	Lettuce production in unheated Dutch light houses	176
45.	Crop irrigation by means of rotary rainers	177
46.	Crop irrigation by means of oscillating spray lines	177

PART ONE

THE GENERAL SUBJECT

CHAPTER ONE

The Status of the Vegetable Growing Industry

The Role of the Grower in National Life. The vegetable grower occupies an important place in the organised life of any nation, for upon his skill as a producer depends one of the most important (some would say *the* most important) of our supplies of foodstuffs. The diet of modern civilised communities normally consists in its broad aspects of bread, vegetables, fruit, sugar and dairy products, plus a little meat or fish. As we shall see presently, no single constituent of this mixed diet contributes so largely to the health and general well-being of the individual as fresh vegetables. It is, therefore, clear that all who are engaged in producing and distributing vegetable foodstuffs are performing a vital and indispensable service to the community.

From another point of view the vegetable grower also deserves recognition. In respect of some of the crops produced it can be claimed that he is making a most effective use of the nation's heritage—the cultivable soil. For example, the potato grower who is raising on an average six tons of usable potatoes from an acre of land is certainly obtaining more actual human food from that acre than is possible by any other type of farming. In round figures, a ton of potatoes contains at least 400 lb. of dry matter, which means 2,400 lb. for a 6-ton crop. Fully to appreciate the high food-yielding value of this crop it may be compared to a 1-ton-per-acre yield of the wheat crop, which is probably the most useful human food crop outside the vegetable class.*

* It is commonly held that 100 acres of land tilled and cropped to potatoes will produce in an average crop sufficient calories to feed 400 persons for one year. The same acreage tilled to wheat will feed 120 persons for one year.

It is probable that as time goes on, and if the human race continues to multiply at the present rate, the food problem, at least in some of its aspects, will grow ever more acute. The term food is here used to denote adequate nutrition, not mal-nutrition, with all that the former implies in terms not only of sufficient protein, carbohydrate and fat but of essential minerals and vitamins. One reaction of this ever-pressing problem will probably be a recognition of the fact that all cultivable land, that precious few inches in depth of the earth's surface upon which all human life depends, must more effectively and efficiently be used in the interests of the common welfare. It is obvious that in such planned utilization the vegetable grower plays an important role.

The proportion of protein food in dietaries is an important factor in human nutrition, and when protein is in short supply mal-nutrition is induced. There will probably never be sufficient meat, cheese, eggs and fish to supply the world's population with its needs of protein. Moreover, some traditional sources of protein appear to be uneconomic or rather wasteful. Meat production by means of livestock, for example, appears to be distinctly wasteful when it is realised that an ox lays down as meat only about 9 per cent of its lifetime intake of protein. If it is reckoned that an acre of well-managed grass in Great Britain will yield per annum 600 lb. of protein, and that a fattening ox converts that 600 lb. of grass protein into 190 lb. of consumable beef representing only about 40 lb. of protein, the inefficiency of this method of meat protein production becomes apparent. In other words, an acre of land has produced in terms of human nutrition only 40 lb. of protein a not very efficient use of the land as a protein producer. The milch cow, it is worth mentioning, is a more efficient converter of grass protein, for she will yield about 15 per cent of her lifetime intake of protein, if in terms of milk production the output of an acre of grass be reckoned at 200 gal. of milk per annum, representing approximately 72 lb. of protein. Thus the cow is a more efficient producer of human food than the ox.

As opposed to livestock conversion of grass protein to protein for human consumption there is the direct production of consumable vegetable proteins by the vegetable grower. Such proteins are available in any quantity from such sources as leguminous crops (peas and beans). It is true that vegetable

proteins of this type are not ranked by nutrition authorities as the best, but they are nevertheless protein foods and are readily assimilated by most human beings. The Eastern races consume little else but vegetable proteins, mainly pulses. An acre of land planted to peas for drying will yield approximately 500 lb. of protein, on the basis of a 1-ton-per-acre crop, which indicates how more efficiently the land may be utilized by cropping as compared with the grass-protein converters—the ox and the cow. Moreover, from the purchaser's standpoint such vegetable proteins are very much cheaper. Nearly four times as much vegetable as animal protein is obtainable for a given sum.

It is possible that economic and other conditions will in future require that a much greater use be made of vegetable proteins of this type, and the grower who raises these crops efficiently will be rendering an even more valuable service to the nation than he is at present.

The Nature of Vegetables and their Food Value. There is a great range of variation in the parts of plants that are consumed as human food. With some plants it is the tuber or bulb formed as a storage reservoir either above or below ground (potatoes, Jerusalem artichokes onions) ; with others it is the fleshy tap-root, also a storage reservoir (carrots, parsnips, beetroots, turnips) ; and with yet others it is the leaves and flowering portions (cabbage, cauliflowers). With one important group of plants (peas and beans) it is the seeds, both green and ripe that are consumed, the plants themselves being discarded.

It follows, then, that the food value of vegetables varies with the proportion of the plant consumed. Plants derive their tissue-forming constituents from various simple substances extracted from the air and soil by the leaves and roots. These materials are elaborated in the cellular system of the plant to form a great variety of complex compounds. Starch and sugars (sugars primarily) are evolved by the green leaf from carbon dioxide and water in the presence of sunlight, and stored in the plant in many different ways. By means of this photo-synthetic activity of the leaves the plants make use of the carbon contained in the carbon dioxide of the air, but how they do it remains one of the greatest puzzles of science. Nitrogen in the form of soil

nitrates is utilized by the plant cells not only as a constituent of protoplasm but to form proteins and fats, while valuable plant pigments, such as carotene, and substances such as gums, acids, alkaloids and enzymes, are also evolved and play their part. Various mineral substances, important to their functioning are taken up and held in their tissues by plants. Lastly, plants evolve those valuable substances known as vitamins, of which there are several distinct kinds known to science, which are invaluable to man as accessory food factors.

The composition of plants varies according to their age, and is influenced to a certain extent by the nature of the soil, manurial treatment and general conditions under which they are grown. It is always of importance, therefore, to know at what stage vegetable crops should be gathered in order to obtain their maximum food value.

To sum up, the substances present in vegetables that are of value as food to the consumer may broadly be classified as follows :—

A. Body warmers and energy fuel—the Carbohydrates—starch, sugars, etc.
B. Body warmers and functional substances—the Fats and Oils.
C. Body builders—the Proteins—compounds containing nitrogen.
D. Protective, functional and bone-building substances—the Salts and Mineral Elements.
E. Protective and health-promoting substances—the Vitamins.
F. Functionary aids—the Crude Fibres.

Carbohydrates. In plants these consist mainly of starch, sugars and cellulose. The compounds of this type supply energy and heat to the consumer.

Fats and Oils. These are more valuable as a source of energy than any other constituent. It is usually accepted that 1 unit of fat is, for this purpose, equal to 2¼ units of carbohydrates.

Proteins. These important compounds contain nitrogen, not contained in the carbohydrates, and give rise to the important group of amino-acids into which they are split by action of the digestive juices. These are substances utilized to the greatest

extent in the human system ; there is very little waste. Recognised as "flesh formers", or body builders, proteins play their part in the formation of muscle, hair, gelatine and other animal cellular tissue. Ingested proteins must be what is termed "high-class", *i.e.* digestible and capable of supplying certain amino-acid units to serve as structural and repair material in the body. Part of their nitrogen is excreted from the system in the form of urea—a simple amide.

Crude Fibre. All fibrous portions of the consumed plant that resist digestion are classed under this head. Although of no direct nutrient value the presence of this material in the human system is, nevertheless, of considerable value. As "roughage" it assists in warding off constipation, a source of many ailments, by aiding the muscular action of the intestines.

Salts and Mineral Elements. The value of the mineral salts present in plants is often overlooked, but these constituents provide a most important aspect of the part played by vegetables in our daily diet. It is generally accepted that a sufficient supply of mineral constituents is necessary to the nutritional intake. Minerals and salts are utilized, along with albuminoids, in the formation of bone and teeth, in the composition of the body fluids and blood, and in the general functioning of the system. The metabolism of human, and all animal life, is so ordered that it selects and uses those mineral substances it needs and rejects the surplus. In fruits and vegetables these substances are found in what is probably the most suitable form for assimilation.

Vitamins. The substances known as vitamins, of which several, including the important A, C, D, E, G and B group, are known to science, are essential for the proper growth, health and functioning of animal bodies, and with the exception of D occur in more or less quantity in most natural foods, such as fruits and vegetables, especially green vegetables. It is true that some, such as vitamin C (ascorbic acid), may be either dispersed or partly destroyed in cooking treatments, and that is why raw vegetables, salads, etc., are more valuable in the human diet than when cooked.

Again, the important vitamin A, so essential to growth and reproduction, and the prevention of eye diseases, is derived from lettuce, spinach, watercress and carrots in the form of the

pigment carotene, which is convertible in the body to vitamin A. The green unbleached leaves of the cabbage family and lettuce are, therefore, more valuable as food, from this standpoint, than the hearts. Blanched celery stalks, the roots of turnips and beet, the bulbs of onions and shoots of asparagus rank rather low as regards vitamin content, but green beans and peas, cabbage, kales, Brussels sprouts, turnip greens, carrots, spinach, watercress, lettuce and tomatoes all rank high as suppliers of vitamins A, B group, C, E and G. Although dried peas and beans contain no vitamin C, this develops when they begin to sprout. Potato tubers are a reliable, though varying, source of vitamin C and constitute a steady source of supply.

It is essential, when considering the fuel and body building value of vegetables, to remember that their water content is high, ranging from about 77 to 96 per cent. Because of the bulk that would have to be ingested, some of them cannot be considered of great importance as suppliers of carbohydrates (energy food), although a few—potatoes, yams and sweet corn for example—rank high as starch suppliers, and carrots, beet and parsnips as sugar suppliers. Similarly, as regards protein, no vegetables, with the exception of beans and peas, contain more than 3 per cent of this food substance. Both peas and beans, however, are of exceptional value as a source of protein, containing in the dried state approximately 25 per cent. Fats (oils) are generally lower than 1 per cent in vegetables.

It is, then, as suppliers of mineral substances and vitamins that vegetables deserve chief attention, apart from any value as suppliers of carbohydrates, proteins, and fats. It has been established that at least ten mineral elements are required in quantity in the growth, development and functioning of the human body, and three of this number, calcium, iron and phosphorus, are often insufficiently available in the daily diet. It is known that vegetables are a valuable source of iron and calcium, while phosphorus is available in milk. Iodine, also needed by the human body, is derived from certain vegetables, notably onions and watercress, provided the soil or water in which they are grown is not deficient in this substance.

Much depends, however, on the manner in which vegetables are prepared for the table. Preliminary soaking in water after peeling, followed by excessive boiling, is the least satisfactory

method of treating vegetables, because much of their valuable mineral content is apt to be lost in the water. Baking, steaming or simmering (casserole cooking) are the best treatments for all vegetables that need cooking to render them palatable or digestible. Certainly, from the health-promoting point of view vegetables that can be eaten raw—lettuce and other green salads, including cabbage (grated), tomatoes—are most valuable. Further, when any form of cooking is required most vegetables are better, both as food and as vitamin suppliers, if the skins are left on, although this is not always practicable.

Lastly, it can be stated that canned vegetables are as fully nutritious and valuable from the health point of view as vegetables prepared by home cooking methods; in fact, it is probable that the treatment to which they are submitted in modern canning plants yields a better product than results from inexperienced and wasteful methods of home cookery.

So much, then, for the status of this important industry and the place of vegetables as food and health promoting substances in the national life of the nation.

*A Table of Vitamin Values in Vegetable Food Substances used by man.**

Symbols are used to indicate to what extent vitamins are present in each food; so that

Three crosses (xxx) mean "very rich source."
Two crosses (xx) mean "moderately rich in."
One cross(x) means "some, but not very much."
V.L. means "very little."
O. means "none at all."
— means "doubtful" or "not yet discovered."
"Reaction" means the character of the residue remaining after complete or partial digestion.

	Vitamins				*Digestion reaction*
Peas and Beans	A	B	C	D	
Fresh French and Runner Beans with pods (Protein and Carbohy) ...	x	xx	xx	—	Alkali forming
Fresh Broad Beans (Protein and Carbohy)... ...	x	xx	xx	—	Acid ,,
Fresh Green Peas (Protein and Carbohy)... ...	x	xx	xx		

*Prepared from the *Manual of Nutrition*, 1947. Ministry of Food, London. H.M. Stationery Office.

	Vitamins				Digestion reaction	
Peas and Beans	A	B	C	D		
Dried Peas (Protein and Carbohy.)	x	xx	0	—	Acid	,,
Dhals (Split Peas (Protein and Carbohy.) ...	x	xx	0	—	Acid forming	
Nuts and Seeds						
Coconut (Protein and Oil)	x	xx	0	—	,,	,,
Ground Nut (Peanut) ,,	V.L.	xx	0	—	,,	,,
Walnuts ,,	V.L.	xxx	0	—	,,	,,
Almonds ,,	V.L.	xx	0	—	,,	,,
Other Nuts ,,	V.L.	xx	0	—	,,	,,
Root Vegetables, Tubers and Bulbs						
Potato (Carbohydrate, Protein and Minerals) ...	V.L.	x	xx	—	Acid forming	
Beetroot ,, ...	V.L.	x	x	—	Alkali	,,
Onions (Bulbs) ,, ...	V.L.	xx	x	—	,,	,,
Onions (Spring) ,, ...	xx	xx	x	—	,,	,,
Garlic ,, ...	x	x	xx	—	,,	,,
Carrots ,, ...	xxx	x	x	—	,,	,,
Turnips ,, ...	V.L.	x	xx	—	,,	,,
Yams ,, ...	—	x	x	—	Acid	,,
Sweet Potato ,, ...	xx	xx	xx	V.L.	,,	,,
Leeks ...	x	x	xx	—	Alkali forming	
Radishes ...	V.L.	x	*x	—	,,	,,
Green Leafy Vegetables						
Lettuce (Carbohydrate, Protein and Minerals) ...	xx	x	x	—	Alkali forming	
Spinach ,, ...	xxx	x	xxx	—	,,	,,
Turnip Tops ,, ...	xxx	x	xx	—	,,	,,
Cabbage ,, ...	xxx	xx	xxx	—	,,	,,
Brussels Sprouts ,, ...	x	x	xxx	—	,,	,,
Watercress ,, ...	xxx	x	xxx	—	,,	,,
Other Vegetables						
Tomatoes (raw) ...	xx	xx	xxx	—	Alkali forming	
Celery ,, ...	—	x	x	—	,,	,,
Cauliflower ,, ...	0	x	xxx	—	,,	,,
Cucumbers ,, ...	V.L.	x	x	—	,,	,,
Pumpkins ,, ...	x	x	x	—	,,	,,
Eggplant ,, ...	—	x	x	—	,,	,,
Veg. Marrow ,, ...				—	,,	,,
Okra ,, ...	—	x	x	—	,,	,,
Kohl Rabi ,, ...	V.L.	x	x	—	,,	,,
Asparagus ,, ...	x	x	x	—	,,	,,
Rhubarb ,, ...	—	—	—	—	Acid	,,
Mushrooms ,, ...	V.L.	V.L.	V.L.	—	,,	,,

The principal sources of vitamin E are *fresh* lettuce, spinach and watercress. The amount of vitamin C in green vegetables is always highest in the spring and early summer months when the plants are growing rapidly. Wilted green vegetables contain less vitamin C, and stored potatoes contain less than the freshly dug.

Remember these vitamins.

Vitamin A. Protection against colds, influenza, Affects vision.

Bs. Promote a healthy nerve condition and proper functioning of digestive tract.

C. Maintains blood and blood vessels in good condition, also joints. Effect of shortage is often mistaken for rheumatism.

D. Essential for bone formation and preservation of teeth from decay. Regulates use of calcium by the body.

E. Affects the generative functions. Important effect on fertility.

It remains only to emphasise the importance of the fresh vegetable market. The expeditious handling of vegetables between producer and consumer is a matter of vital necessity, because a fresh, clean supply of this type of food is an indispensable factor in the social well-being of the community. In this connection the statement made by Lord Horder, the eminent physician, when addressing the International Congress of Agricultural Producers held in London in May, 1946, is of interest. After referring to the importance of fresh vegetables in the national diet, Lord Horder said*: "When it was possible there should be an increased consumption of milk, a high preference for vegetables, especially green and salad vegetables, and a consumption of sugar perhaps 25 per cent *below* the average pre-war level. They needed to shift the preference from sugar and manufactured foods containing sugar towards milk and vegetables and supplement the average milk and cheese intake with fish."

**The Times*, May 26, 1946.

CHAPTER TWO

A Survey of Production

From a study of available figures it seems clear that the annual amount of land in England and Wales devoted to the production of vegetables other than potatoes *before* the last war was approximately 275,000 acres. On a basis of 6 tons per acre home production provided about 1,650,000 tons, or about 1.6 lb. per head per week. In former times, too, there has always been a heavy importation of some kinds of fresh vegetables, notably cauliflowers, carrots, onions, tomatoes and salads (lettuce, endive and chicory). The total weight of such imports in 1937, the last "normal" year's figures available[1] amounted to 12,920,000 cwt. with a declared value of £9,339,000. Onions were an astonishing importation, amounting to 4,805,000 cwt., while tomatoes amounted to 2,714,000 cwt.

Obviously, in such circumstances the country's full production resources were not being used, and the necessary expansion of production called for under war conditions, not only to make up the loss of imports but to meet the increased consumption brought about by the shortage of other kinds of foodstuffs, was well within the industry's producing capacity. Thus it is of considerable interest to note that by the year 1944 the acreage cropped to vegetables had been raised to 450,000 acres, that is, by more than half as much again as the peace-time figure.[2] The crops that had been particularly singled out for extension were as follows :—

Outdoor tomatoes	increased by		...	2,300	per	cent.
Onions	,,	,,	...	806	,,	,,
Peas	,,	,,	...	333	,,	,,
Carrots	,,	,,	...	119	,,	,,
Green Vegetables	,,	,,	...	51	,,	,,
Cauliflowers and broccoli	,,	,,	...	33	,,	,,

[1] Fruit Supplies 1937, including vegetables, flowers and bulbs. Imperial Economic Committee, London. H.M.S.O. 1938.

[2] Taylor, H.V. The National Vegetable Programme. Wores. Agric. Chron., Vol. XIII, No. 1, March, 1945.

This extension was, of course, mainly accomplished by taking in more farm land for vegetable cropping, but the fact that outdoor flowers were compulsorily reduced by 75 per cent, and hardy nursery stock by 53 per cent, also had a bearing.

Vegetable cropping in Britain is still considerably expanded, for supplies from the Continent, though rapidly mounting, have not, with the exception of salads, resumed former proportions. The position is also changed basically as a result not only of the constant and consistent advice given to the public by the nutrition experts during the war period, the effect that the consumption of fresh protective foods of the vegetable type should be substantially increased even to the extent of 70 per cent of pre-war consumption, but also because of the scarcity of fresh meat. There can be no doubt that the consumption of vegetables has increased, and it may, with the enlightened view of the public, continue to increase until it reaches the figure of 2.6 lb. per head of the population per week advocated by scientific authority. Thus it might fairly be said that the absorbable production acreage for vegetables might well be set at something over 500,000 acres, even after allowing for some exports.

The potato, which ranks as a vegetable crop, is an important (perhaps *the* most important) food crop in the British Isles, and is not included in the above survey. A very large acreage of some of the best arable land is annually devoted to this crop, the total area in the United Kingdom and Eire in the ten years 1926-1935 averaging 1,123,000 acres, of which 487,000 acres were in England and Wales, and 140,000 acres were in Scotland.[3] The average annual yield was 7,517,000 tons or approximately 6 tons per acre. In addition to the home production during this period a fair quantity, though comparatively light and mostly new potatoes, was imported. Under war-time conditions imports of potatoes were stopped and home production was expanded considerably to meet an increased consumption. The role of the potato during the last ten years of the nation's life cannot be overstated, for it proved to be not only a reliable mainstay of the country's food supply, but an

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[3] Acreage and production of potatoes in the United Kingdom and Eire. Imperial Economic Committee, Weekly Fruit Intelligence Notes. Vol. XII. No. 28, 1938.

important and almost indispensable source of vitamin C. It is a food crop that not only sustains life but maintains health.

It is estimated that 75 per cent of the population consists of urban and suburban dwellers who find it impossible to grow entirely their supplies of fresh vegetables. They are purchasers of vegetables, and it was this always-increasing section of the population which, centuries ago, brought into existence the business of market gardening, which, as time passed, grew steadily into one of the major industries connected with the land.

A little more than a century ago, before the advent of railways, fresh vegetables were produced in the vicinity of the consuming centres, and the horse-drawn vehicles laden with produce on their way to the markets overnight, and returning home next morning laden with stable manure for the land, were a familiar sight of the highways. The intensively-farmed market gardens of this period were never more than 12 or 15 miles from their markets. The market garden districts of Middlesex, Kent and Essex, which served the population of London, were at the height of their prosperity in those days.

With the coming of railways it became possible to raise crops further afield; the only basic requirements being that the land should be suitable for market gardening and within easy reach of a railway station. The indispensable supply of town stable manure was brought to the new districts by railway, and in the same manner the produce was carried quickly into the cities and markets. In this way large new market gardening areas, such as the Biggleswade district of Bedfordshire, were developed and prospered for nearly another century before the advent of motor transport brought about another change—and this time a change of a more serious, even revolutionary, character. It is, in fact, impossible to avoid the conclusion that with the invention of the petrol engine a new era dawned for the market gardening industry. The advent of motor road transport held out not only the possibility of producing vegetable crops anywhere within a radius of 100 miles or more of the markets to be served, but of quick and efficient transport that saved both time and money. Thus a fresh and vigorous competition confronted the old-established market garden districts, which had to face a still more difficult situation when motor transport having replaced horse transport in the towns, it

became apparent that a time-honoured source of fertility, town stable manure, was rapidly vanishing.

Fortunately, this period coincided with a remarkable development in the manufacture and distribution of fertilizers, both organic and inorganic, the judicious use of which has undoubtedly assisted market gardeners to cope with some of the difficulties associated with diminishing supplies of organic manure.

The market gardening industry was fated, however, to witness yet one more revolutionary change in the situation. About the beginning of the decade in which this book was first published the depression in the cereal market caused arable farmers to cast about for fresh crops to grow. They soon discovered that vegetables provided them with useful cash crops which, more often than not, were saleable at remunerative prices. If unsaleable, such crops could be fed to the livestock of the farm and little or nothing was lost. The last twenty years have, then, witnessed an enormous development of vegetable growing on large farms. Vegetables, like other crops, appreciate fresh land, and the farmer who operates on a large scale is able to provide a better rotation of cropping than the intensive market gardener. Moreover, the farmer is able to make full use of mechanized cultivation, which in turn makes for a reduction of production costs. It is safe to say that large-scale mechanized operators have reduced by one-half the costs of producing many vegetable crops, and the public have, of course, benefited substantially. Much of the difficulty associated with the growing of vegetables on intensive market garden lines is the high cost of labour due to the unavoidable use of much hand work. A further point is that the market garden is usually without any important source of home-produced fertility, owing to the absence of livestock, except a few horses that are kept for work, and perhaps, a few pigs. The large farmer usually maintains bullock yards, dairy herds, piggeries or flocks of sheep, all of which contribute manure for the land.

It is fairly safe, therefore, to say that the production of vegetables by farmers has come to stay. For these crops are a useful source of ready cash and present no difficulties in handling once a connexion with the merchants and markets is established. Again, this type of production has lent itself to the distribution of crops over such a wide area that crops can

be raised in those districts that suit them best. For examples, the production of brussels sprouts has moved from the light soils of Bedfordshire to the stronger loams of Cambridge, Norfolk and Suffolk, which are more productive. Broccoli has became a notable crop on Devon and Cornwall farms. The production of carrots has centred in the Fens and on the light soils of Suffolk; asparagus has turned out a successful crop on the light sands of Norfolk; and celery and lettuce have become established on the cool, eminently suitable soils of the Fen-land districts. These examples could be multiplied, but will serve; the point is that this "zoning" of vegetable production is actually a form of planned development that has come about naturally as a result of the factors that have been touched upon. That the consumer benefits is beyond question: not only has he benefited from lower price levels but he has reaped the advantage of a high standard of quality.

But while the production of vegetables was extending from the market garden to the farm, this period, which witnessed the increasing difficulties of the old intensive system of vegetable growing, also saw the development of a new type of intensive production. When for the first time in the history of the market gardening industry, a range of tariff duties on imported early vegetables was imposed in 1931, that action generated among home growers an interest in the production of the early and out-of-season vegetables and salads that had been imported in such large quantities from the Continent. This type of production calls for the employment of skilled labour, and the use of such devices as Dutch lights, heated frames, continuous cloches, soil-heating and overhead irrigation. The early experimental units of this type of production gave promising results and led to a considerable extension of this super-intensive type of market garden. An account of this class of production is given in Chapter XII, and Dutch lights are illustrated in Fig. 41. There is little doubt that this type of production is now firmly established on a commercial basis and forms an important link in the chain of production.

Yet another type of production has come into being during the last twenty years,the large mechanized unit almost entirely devoted to vegetable growing. These specialized units are noteworthy because they differ from the ordinary mixed farm type of unit by reason of the fact that livestock—whether

horses, cattle, sheep or pigs—is absent, the tillage is completely mechanized, and fertility is maintained by the use of both organic and inorganic fertilizers plus short leys and adequate cultivations.

To sum up, therefore, the production of vegetables for market in this country is now carried on under four different systems, as follows :—

1. The intensive market garden—old type.
2. The super-intensive market garden—new type.
3. The large-scale mechanized unit.
4. Mixed farm production.

If the first-mentioned system is the only one that gives rise to any anxiety as regards its future prosperity, it is solely because the old type of intensive market gardening has to face several difficulties, not the least of which is the strong competition from other sections of the industry—from the mixed farm and the mechanized unit. Other factors that operate against the success of the old system are the decline of fertility in the absence of the copious supplies of stable manure formerly used, and a steady increase in the annual losses from pests and diseases due to the fact that the same crops are too frequently grown on the land. It is true that many of the smaller types of these intensive market gardens are carried on by means of "family" labour, so that the economic aspect of the undertaking hinges to a great extent on the fact that as no hired labour is employed, and there is no considerable weekly wages bill to meet, the family income consisting of the entire earnings of the holding. Nevertheless, it is clear that growers of this type will have to make every use of the knowledge available from modern scientific investigation if their land is to continue to yield returns at remunerative levels.

Crop Disposal. The grower disposes of his produce by sending it to wholesale markets, or by selling direct to merchants, retail shops, hotels, restaurants and individual consumer.

The main channel through which supplies of fresh vegetables have always reached the consumer is the wholesale market. Wholesale markets, from which retail distributors obtain the bulk of their supplies, developed as an indispensable feature of city and town life, and were directly linked up with

the market gardens that fed them with supplies by road. They are run mainly by market salesmen. One of the features of the development of production away from the immediate neighbourhood of the cities and towns was the number of salesmen who themselves became producers, a step which tended towards the maintenance of the long-established wholesale markets, as both the growing and selling of vegatbles often went together, becoming a family business.

In later years, particularly since the advent of the farmer-producer, there has been an increase in the number of wholesale merchants, or middle men, who handle supplies of vegetables between the market salesman and the producer. These wholesale merchants usually operate on a large scale, and being in touch with the wholesale markets all over the country are able to buy in large quantity and arrange a very rapid disposal. This type of distribution has also promoted an increase of the custom of selling crops "on the ground" and also of the custom of producing "on contract". It is a form of crop handling that appeals to the farmer-producer who, knowing little of the requirements of the markets, is often glad to sell a crop to a merchant at an agreed price per acre. He is also often quite willing to contract with a merchant for the production of certain crops at an agreed price per acre, provided that he can see a fair profit on his tillage and land charges. Thus it is clear that the wholesale merchant forms a useful link in the distribution chain.

It is clear from what has been mentioned that the maintenance of wholesale vegetable markets is dependent on a variety of factors of which the convenience and interests of the retailer or consumer-buyer are not the only ones of importance. It should be remembered that the wholesale market is also a distributing centre for home-grown supplies of fruit and flowers and such foreign fruits and vegetables as continue to arrive. While most of the buyers who visit the wholesale markets consist of wholesalers and retail shop-keepers, other buyers comprise hotel and restaurant keepers (who nearly always buy direct from salesmen), street hawkers and itinerant roundsmen. Not all the retail shop keepers, however, confine their buying to the wholesale markets, for of late years the advent of the cheap and efficient motor truck has brought into existence a new type of middleman who confines his activities mainly to

the smaller industrial towns of the Midlands. This type of distributor visits the producing districts where he collects a miscellaneous load of seasonable produce from the growers, which is then delivered to a number of shopkeeper customers in a selected town. Orders for the next round of delivery are usually booked at the same time. These distributors are usually able to offer the grower higher prices than he can realize by sending his produce to market, while there is a distinct saving in transport, packages, etc.

Other Forms of Crop Disposal. The methods generally adopted for disposing of vegetable crops for consumption in the fresh condition having been described, it remains to mention the other outlets for crops, some of which, notably canning, have developed very considerably in recent times.

Canning. The canning of vegetables has become nearly as important, in terms of quantity handled, as the canning of fruit. As a rule the same factory handles both vegetables and fruit, the former being fitted into the factory routine when the plant is unoccupied or less busy with fruit. While British canning factories can be kept supplied with such crops as peas, green beans, carrots, beetroot, turnips, celery, spinach and potatoes to the full capacity of their requirements, we are unable to supply them with such produce as tomatoes, asparagus and dried beans. Tomatoes and asparagus are seldom in sufficient supply to meet the demands of the fresh trade, while the climate is not very suitable for growing the small pea-beans (at least those varieties grown in the U.S.A.) used for canned baked beans. Attention has, however, been directed to the task of breeding varieties suited to the climate. Meanwhile, this type of bean is imported in considerable quantity. There seems to be no good reason, however, why asparagus for canning should not be grown, because conditions in Britain are as good for this crop as elsewhere. Most of the tomatoes used for canning are purchased at prices much lower than those commonly ruling in Britain, and are grown in the open under climatic conditions rather more suitable than those commonly experienced in this country ; thus this crop seems outside the scope of the home grower's activities.

Sometimes crops have to be of a special type for the canning trade, *i.e.* suitable varieties grown and harvested in a specified

manner. A case in point is the pea crop—a speciality of Lincolnshire. Mostly, however, the canner favours certain varieties for processing and requires the produce in a certain stage of maturity. As a general rule contracts, based on agreed prices, are made with growers (many of whom are farmers) for these supplies, and thus there is little risk. Where needed, specially-written descriptions have been included in the book for the respective crops utilized for canning, *e.g.* green peas, and these should be read carefully by those who are interested in this aspect of vegetable production.

Freezing. Although the produce is not processed in any way, this is a method of handling involving a principle of preservation. Quick freezing was first adopted for vegetables in 1928 and has come very much to the fore in recent years in certain countries such as the U.S.A., where distribution problems, owing to the enormous areas to be covered, are more acute than in European countries. In that country it is estimated that 70,000,000 lb. of vegetables were handled by freezing methods in 1937, and there has been further expansion since.

Two systems, known as "quick freezing" and "sharp freezing" are used. The first is accomplished by various methods of freezing technique, such as floating the produce in pans of flowing brine or on flat metal plates over running brine. Freezing the packed produce between stationary or moving cold plates is another method practised. The second system, "sharp freezing" consists of placing the prepared produce in cold-storage chambers constructed and fitted up for maintaining low (freezing) temperatures. Specially-designed portable freezing cabinets of the self-contained type, on lines similar to the small domestic refrigerator, are now being manufactured for use by growers.

It is commonly asserted that "quick freezing" possesses advantages over "sharp freezing" because the freezing period, being shorter, results in a reduced withdrawal of water from the cells, and the ice crystals, being smaller, inflict less damage on the cells. Moreover, as the produce is cooled down so quickly there is little or no risk of deterioration of quality owing to the activity of moulds and bacteria that cause decomposition.

It is claimed that freezing is the best form of preservation from the point of view of edible quality, and it also preserves

colour and natural appearance better than other methods. Freezing is particularly suitable for vegetables that deteriorate rapidly, such as green peas, green beans, sweet corn and asparagus. The frozen produce is, of course, maintained in that condition until it reaches the consumer, and for its transport handling special refrigerator railway vans and motor trucks are employed. Similarly, in the retail shops refrigerator containers are necessary.

It is a point of particular interest to the industry that quick freezing, despite all the trouble and special apparatus involved, is steadily increasing in favour both amongst producers and consumers. It will undoubtedly play a large part in the future development of the industry.

Pickling. Pickling is a manufacturing process that is annually absorbing no inconsiderable quantities of suitable vegetables. Here also, as in the canning business, supplies are usually arranged for by contract between factory and grower. Also, the crops grown, usually cauliflowers, gherkins, cucumbers, shallots and onions, consist of varieties specially suitable for the trade. The pickle-making business is a useful outlet for the grower and one not at all to be despised. Brining, *i.e.* a pre-process curing by immersion in a salt solution of a minimum concentration of 8 per cent pure salt, is a necessary preliminary process with all vegetables used for pickling. This brining, for which special vats or casks and barrels are used, according to the type of crop, has often in the past been performed on the farm. In these days of rapid despatch by motor transport, however, crops are now largely brined at the factory as they are delivered. Brining is either a blanching or a fermentation process according to the produce under treatment. Fermentation, desirable for gherkins, involves the production of lactic acid by the fermentation of the sugars in the produce, and this in turn influences the flavour, texture and keeping qualities of the produce.

Active brining usually occupies from 3 to 6 weeks. With some vegetables, *i.e.* cauliflowers, the brined material is usually removed from the brine and packed into fresh casks, which are filled with more brine later. Fermented produce, *i.e.* gherkins, is stored in brine concentration to prevent bacterial decomposition. Onions are usually kept stored in the concentrated brine until required for processing.

Dehydration. This, another form of preservation to facilitate the handling of an otherwise quickly-perishable produce, has been widely used during recent years, particularly during the war period in connection with supplies to the armed forces at sea or stationed in remote places.

Dehydration is, of course, a form of drying, but it is not exactly drying as commonly understood. Nor is it, strictly speaking, evaporation. The art of dehydration is concerned with the rapid removal of the water contained in the produce by the use of heat in a special process. It is not, therefore, similar to the slow drying process used in producing dried fruits, such as prunes and raisins, which is really a form of curing. Dehydration is a factory process involving expensive plant and factory routine. While it has its uses it certainly has its limitations. It is useful for such vegetables as cabbage, carrots and potatoes, but does not seem likely to become widely adopted under normal conditions. It is claimed that modern dehydration inflicts little harm on the valuable vitamins.

The old methods of drying plant material—fruits like prunes and raisins, herbs like thyme and sage—all require a comparatively long time, varying from one or two days to a fortnight or more. During this lengthy period, the cells of the plant tissues die slowly. Some of the reserve food materials in the cells, such as sugars, are used up in the meantime and finally there is a partial breakdown of the structure of the living protoplasm of the cell. This allows the mingling together of enzymes and other substances that are normally kept apart in the living cell. The numerous chemical changes that result alter materially the composition of the cell contents, and vitamins, among other products, are to a greater or lesser extent destroyed.

In the new method of drying, known as dehydration, the plant material, after shredding and other preparatory processes such as blanching, is rapidly brought up to a temperature of about 80°C. which causes the destruction of enzymes and brings to an end those chemical reactions for which they are responsible. The whole of the water in the material is removed in a very short time, and this, coupled with the destruction of the enzymes, results in the minimum of change in the cell contents and the preservation of a large part of the vitamins and pigments. Amongst the vegetables dehydration is at present mainly used for potatoes, carrots and cabbage.

Motor Transport. Motor transport has for some time played an important part in the distribution of vegetables, and it is clear that the railways now take second place. In all the more important centres of production there are haulage contractors who specialise in running trucks to all the principal markets at a flat rate on the tonnage basis. The railways, however, are still freely used for much of the bulky produce from a distance, such as potatoes, celery, broccoli and cauliflowers. While many vegetable growers maintain their own motor trucks on the road it is doubtful whether this course is profitable unless the production unit is a large one, say not less than 300 acres, so rendering good loads available almost every weekday throughout the year. For smaller acreage producers the haulage contractor gives the most economic service. Low road haulage costs can be obtained only by keeping the trucks constantly on the road, and it is usually found that haulage firms who specialize in the road transport business can quote the lowest possible transport rates vegetable growers can obtain. The large wholesale merchants who arrange for contract growing, and buy crops "on the ground", usually run their own trucks, as they can keep them busy all the year round.

A word should now be said here as to the economic aspect of the vegetable growing industry.

There is every reason for believing that the future of vegetable production for market, except in the case of the super-intensive undertakings devoted to early crops, lies in the direction of large-scale operations, either as mixed farming units or large specialist units run on mechanized lines. As it is safe to conclude that neither system can be maintained for an indefinite period without the use of farmyard or other organic manure, it is therefore arguable that the vegetable grower of the future will either be compelled to go in for livestock of some kind, e.g. pigs or yard-fed bullocks, for the express purpose of manure-making or embark on a large-scale system of compost making. Alternatively, he may find it expedient to introduce a system of short-term leys to maintain soil structure and fertility.

Because, too, of the fact that an important point in the production of vegetables is to produce in bulk, in other words, to grow sufficient of each commodity, whether it be peas, beans, carrots or brussels sprouts, to maintain a steady flow of substantial consignments, large-scale operations again meet the

case. This type of production always commands the interest of market salesmen and merchants who prefer to have dealings with large "senders". Wholesale merchants who buy in a large way are also not interested in small lots, nor, for that matter, in several different varieties of the same commodity.

Efficient and economic tillage, irrigation, and the full use of mechanization are a difficulty with small units, and it may be said that, as a rule, the smaller the unit the higher the cost of production. To-day the public is entitled to the advantages of lower production costs. While some of the most successful large-scale units devoted to vegetable production extend to 2,000 acres, units of this type should certainly not be less than 300 acres and the land should be uniformly good. Actually the advantages are all in favour of units of twice this acreage.

On the other hand, when vegetables are worked into the ordinary rotations on mixed farms the crops conform to the general farming policy, and on efficiently managed holdings of extended acreage the production costs are seldom very high. In many instances the cash value of the crop for stock feeding purposes is the basic consideration.

Some idea of the relative importance of the various vegetable crops may be gathered from the statement on Page 39. There are roughly thirty different vegetable crops grown commercially for market in England and Wales. Most of these are given in the order of importance based on tonnage of output. Both the estimated average annual acreage and tonnage of production for the checked period 1930-1932 are given where known. The figures given were taken from "*Vegetable Marketing in England and Wales*", issued in 1935 by H.M. Stationery Office on behalf of the Ministry of Agriculture.*

It was also estimated that an average of 8,700 tons of turnip-tops were marketed from 8,700 acres, and that an average of 22,000 acres of land were devoted to the production of 18,000 tons of dried peas (blues and "marrowfats") for human food.

After the imposition of tariff duties on vegetables, as from December, 1931, there was a considerable reduction in the annual quantities of produce imported from abroad. The least

* Econ. Series No. 25, price 1s.

affected commodity was ripe onions, the importation of which (before the introduction of tariffs it amounted to 226,800 tons), was still as high as 224,500 tons in 1934. The effect of a tariff duty on a commodity that can be grown at home was shown by the figures for cauliflowers and broccoli. Before the tariff duty was imposed importations amounted to 37,100 tons, but in 1934 the figure had dropped to 7,000 tons, a reduction of over 30,000 tons of one type of produce.

Commodity.	*Acreage.*		*Production in tons.*	
1. Cabbage: Spring Cabbage and Cabbage Greens	12,000	42,880	84,000	439,130
Autumn and Christmas Cabbage	25,000		300,000	
Scotch and other Kale ...	700		8,500	
Red Cabbage	160		1,450	
Savoys	5,020		45,180	
2. Cauliflower and Broccoli ...	21,000	22,250	170,000	176,250
Sprouting Broccoli ...	1,250		6,250	
3. Green Peas	59,000		132,000	
4. Brussels Sprouts	32,850		121,000	
5. Carrots (topped maincrop) ...	10,000	10,600	117,000	119,700
(Bunched early)	600		2,700	
6. Turnips (bunched)	640	9,640	3,200	103,200
Topped, and Swedes ...	9,000		100,000	
7. Rhubarb (Natural)	5,000		65,000	75,000
(Forced)	—		10,000	
8. Celery	7,380		75,000	
9. Beans: Runner Beans ...	—		43,000	69,800
Kidney Beans	—		12,000	
Broad Beans	—		14,000	
Forced Beans	—		800	

A further impression of the importance of vegetable production in England and Wales may be obtained from a study of the acreage figures over a ten-year period. Such figures are

Commodity.	Acreage.	Production in tons.	
10. Lettuce (Outdoor Cabbage) ...	4,200	33,600	45,400
(Indoor Cabbage)	—	1,200	
(Cos)	1,500	10,600	
11. Beetroot	3,350	40,000	
12. Vegetable Marrows (Outdoor)	1,900	25,000	25,100
(Indoor)	—	100	
13. Onions (Green)	1,800	14,400	22,000
(Ripe)	1,100	7,600	
14. Parsnips	2,200	17,600	
51. Herbs: Mint (Outdoor) ...	—	2,160	8,870
Mint (Forced)	—	140	
Sage	150	900	
Thyme	—	270	
Parsley	900	5,400	
16. Leeks	1,200	8,400	
17. Spinach	1,500	6,000	
18. Radishes (Outdoor) ...	845	5,100	5,450
(Indoor and frame) ...	—	350	
19. Watercress	—	5,000	
20. Artichokes (both types) ...	—	2,600	
21. Mustard and Cress	—	2,500	
22. Asparagus (Outdoor) ...	—	1,200	1,245
(Forced)	—	45	
23. Mushrooms (Forced) ...	—	1,050	
24. Seakale	—	700	
25. Horse-radish	—	200	
26. Shallots	—	100	
27. Witloof Chicory	—	under 50	

Photo by courtesy of Messrs. W. Reynolds & Son Ltd. Bedford

FIG 1.—The Caterpillar tractor cultivating Boulder Clay.

MECHANIZED PRODUCTION

High-powered cultivating units are now used on modern vegetable-growing farms.

FIG 2.—The *Lanz* track laying tractor drawing a five-furrow plough.

FIG 3.—A general view of a modern market garden.

Note pumping station for irrigation in centre of unit and packing shed at far end adjacent to highway.

Carrot growing in Suffolk —Preparing the land.

FIG 4.—Tillage with a *Fordson* Tractor.

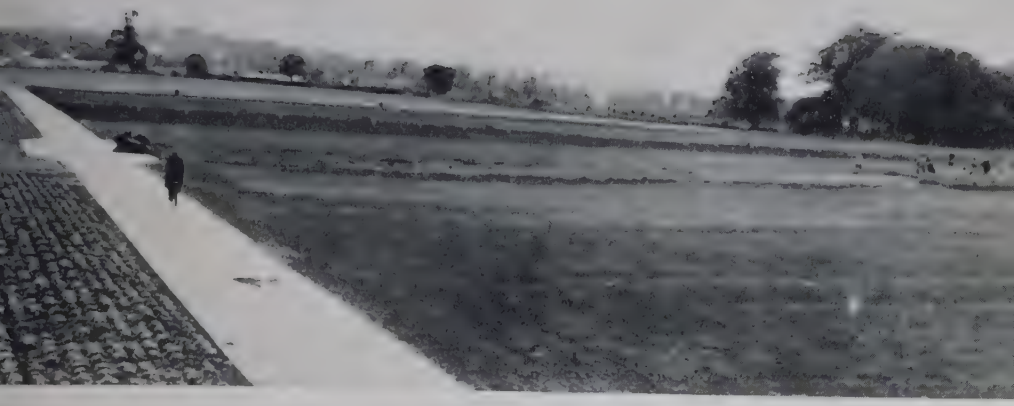

Photo by courtesy of M. F. A. Secret

Carrot growing in Suffolk—Preparing the land.

FIG. 5.—Applying the fertilizer.

Fig. 6.—Road Planing with Ribbers. Stresses Spruce.

Fig. 7.—Instrument planing. The transparency at work.

obtainable from the June returns obtained every year by the Ministry of Agriculture and Fisheries. Details are not available for all the vegetable crops, but the table at the end of this chapter gives the figures for the most important fresh vegetable crops. The table following gives the average wholesale prices realised by the range of vegetables commonly in demand over the same period.

Areas of Production. England can be divided into roughly six areas for vegetable production as follows :—

Area.	*Markets mainly served.*	*Rainfall.*	*Average temp. in January.*
The Southern Counties Area	London and Southern Towns	20—30 in.	40°F.
The Home Counties Area	London ...	20—30 in.	38—39°F.
The Eastern Counties Area	London, Midlands and Northern ...	20—25 in.	38°F.
The North and West Midland Area ...	Midlands, South Wales ...	25—30 in.	38—39°F.
The South Western Area	London, Midland, S. Wales & West	30—50 in.	40—44°F.
The Northern Area ...	Northern ...	30—40 in.	38—39°F.
Wales	Local ...	35—60 in.	40—42°F.

THE SOUTHERN COUNTIES AREA, because of its earliness, suitable soils of the easy-to-work type, and the variety of cropping possible, is one of England's most valuable producing areas. It includes East and West Sussex (in the latter the important Worthing district) ; Surrey, where extensive vegetable farming has developed in the Guildford district ; Hampshire ; Dorset and the Isle of Wight. Hampshire is a county with many small growers (it is estimated that there are 3,000), while the Isle of Wight is notable for its mild winter climate, favouring the production of early crops, and its good summer climate favouring outdoor tomatoes. Dorset has in recent years developed vegetable production in the Wimborne and Wareham districts. The markets served by this area are chiefly those of London and the large coastal towns, but early produce and

tomatoes are despatched to the Midland and even to the Northern markets.

THE HOME COUNTIES AREA contains some important districts possessing outstanding advantages both as regards soil and climate. The Rochester, Sittingbourne and Thanet districts are noteworthy for their good loamy soils and equable climate (the latter owing to the proximity of water) that promote the production of early crops. The Swanley district is not quite so early but is a good all-round vegetable district with a fair type of soil. Essex resembles Kent in possessing early districts bordering the Thames estuary where the land is mostly alluvium, with stronger soils further inland, all devoted to early and maincrop vegetables such as peas, beans, and the Brassicas.

The Biggleswade and Sandy districts of Bedfordshire come next in importance in the Home Counties, the famous stretch of light, sandy soil having been under cultivation for over a century. It became noteworthy as the chief centre for brussels sprouts, but this crop has now moved farther afield. On the southern seaboard the Worthing and Southampton districts are both important centres of production, especially for early crops, for some of which glass is extensively used. The last district worthy of note in the Home Counties area is in Middlesex and the part of Bucks adjoining its western boundary. The Heston district is often spoken of as the home of the market gardening industry, for market gardens supplying the London area have flourished here for centuries. Gradually, however, the district is being built over, but many intensive and well-managed establishments are still carrying on. Parts of Herts are well suited to this type of husbandry.

THE SOUTH-WESTERN AREA is noteworthy, as it contains the districts from which some of the largest supplies of broccoli are drawn, the climate being temperate enough to permit of this crop overwintering with the least amount of damage from frost. Broccoli from Devon and Cornwall are sent all over the British Isles. There are approximately 6,000 market growers and farmers growing vegetable crops in Cornwall alone. The Bridgwater district of Somerset is usually the source of the earliest supplies of green peas to reach the markets, being about a week or ten days earlier than the Kentish district.

THE EASTERN AREA, although not notable for early crops on account of the rigorous winter climate, is nevertheless one of the main sources of supply for maincrop vegetables and certain specialized crops, such as celery (a fen-land crop), carrots (also a fen-land crop) and brussels sprouts, which are grown by farmers throughout all the eastern counties, especially Cambridgeshire, Suffolk and Norfolk. The Boston and Spalding districts of Lincolnshire are important areas for spring cabbage, peas and cauliflowers. Although celery is one of the chief vegetable crops of the Fens, it is also produced in the Haxey district of Lincolnshire on silty types of soil. Asparagus growing has also been developed in the Eastern Counties on various types of land, including fen-land, silty loams and the light "blowy" sands of the Thetford district.

THE NORTH- AND THE WEST-MIDLAND AREA has always been noted for market vegetable growing as it contains the important centre of production known as the Vale of Evesham, a large and fairly early district from which an extensive range of vegetables is distributed all over the country. This Evesham district extends for a radius of roughly 12 miles from the town of Evesham in Worcestershire and is particularly noted for its specialized production of such crops as asparagus, peas, beans of all kinds, brussels sprouts, spring onions, radishes and lettuce. Other producing districts of note in this area are centred around the towns of Stratford-on-Avon, Hartlebury, Worcester, Bromsgrove, Tamworth (Staffs), Melbourne (Derbyshire), Chester and Sandbach (Cheshire), from all of which produce in excess of local demand is distributed to distant markets.

THE NORTHERN AREA includes the main industrial regions, but important districts for vegetable production are located here and there where the soil and climate are favourable. In south-west Lancashire celery is grown on the peaty land of the Irlam and Hesketh Bank districts. Vegetables of all kinds are grown in the Ormskirk district for the Liverpool and Manchester markets, which also draw supplies from Northern Cheshire, the Timperley and Wallasey districts being notable for their early production. Asparagus growing has been developed in the Formby district of Lancashire.

On the other side of the Pennines important districts for vegetable growing are located around Hull and Selby in Yorkshire. The Leeds district has become famous for its production of rhubarb, while the Market Weighton district has specialized in the production of carrots. Farther north a district located around Hexham and Morpeth contributes substantially to the supplies of vegetables required for the Tyne-side towns of Newcastle and Sunderland.

Standard Yields. It will be recognised that yields of such crops as those dealt with in this book, being subject to the vagaries of climate and markedly influenced by soil and climatic conditions of each locality, will vary considerably. Early crops will be lighter than maincrops and yet pay the grower better. Nevertheless, the reader will probably welcome information bearing on what might be termed common production standards applicable to this country. It is worth noting in this connection that our production standards for vegetable crops probably are as high as the world can show.

Standards of production for vegetable crops.

Artichokes	10	tons per production acre
Beans (Green) Broad ...	4	,, ,, ,, ,,
Beans (Green) Runner ...	2½	,, ,, ,, ,,
Beans (Green) Kidney ...	1½	,, ,, ,, ,,
Beet (maincrops)	10	,, ,, ,, ,,
Broccoli (500 dozen) ...	6	,, ,, ,, ,,
Brussels Sprouts	3	,, ,, ,, ,,
Cabbage and Savoys ...	10	,, ,, ,, ,,
Carrots (maincrops) ...	12	,, ,, ,, ,,
Cauliflowers (700 dozen) ...	6	,, ,, ,, ,,
Celery	10	,, ,, ,, ,,
Cucumbers	3	,, ,, ,, ,,
Lettuce Cabbage (3,500 dozen)	8	,, ,, ,, ,,
Leeks	4	,, ,, ,, ,,
Onions	7	,, ,, ,, ,,
Peas (in pods)	12	,, ,, ,, ,,
Peas (dried)	1	,, ,, ,, ,,
Parsnips	12	,, ,, ,, ,,
Potatoes	6	,, ,, ,, ,,
Rhubarb (natural) ...	10	,, ,, ,, ,,
Spinach	3	,, ,, ,, ,,
Tomatoes	8	,, ,, ,, ,,
Vegetable Marrows (1,400 dozen)	8	,, ,, ,, ,,
Watercress	20,000 lb.	,, ,,

PRESENT DAY PRODUCTION OF VEGETABLES IN ENGLAND AND WALES IS SEEN IN THIS TABLE, BASED ON THE JUNE AGRICULTURAL RETURNS. FROM *Agriculture*, VOL. LV, No. 1, 1948.

AGRICULTURAL STATISTICS—ENGLAND AND WALES.

Small Fruit, Vegetables and Flowers

(thousand acres)

DESCRIPTION	1939	1946	1947
Strawberries	18.7	12.3	13.0
Raspberries	4.1	2.1	2.4
Currants, Black	1.04	9.1	11.3
Currants, Red and White	2.3	1.5	1.5
Gooseberries	9.1	5.5	6.0
Loganberries and cultivated Blackberries ...	2.5	1.2	1.1
TOTAL SMALL FRUIT	47.2	31.8	35.3
Brussels Sprouts	38.0	46.2	50.7
Remaining Spring Cabbage (planted in 1946)			12.7
Summer Cabbage			10.9
Autumn Cabbage			7.7
Winter Cabbage	44.1	66.9	15.8
Autumn Savoys			6.7
Winter Savoys			21.2
Kale and Sprouting Broccoli			2.7
Cauliflower or Broccoli (Heading)	18.9	33.6	32.4
Carrots	16.1	39.9	33.2
Parsnips	(a)	6.0	5.3
Turnips and Swedes	(a)	11.1	12.7
Beetroot	(a)	13.7	10.9
Onions	1.7	13.2	11.3
Beans, Broad	17.8	7.2	3.9
Beans, Runner and French		11.8	12.3
Peas, Green for Market	60.6	60.6	51.1
Peas, Green for Canning	28.0	19.0	20.1
Peas, Harvested Dry		159.9	170.3
Asparagus	2.6	1.7	1.6
Celery	6.7	7.3	6.4
Lettuce	5.9	8.8	8.4
Rhubarb	7.2	7.6	8.0
Tomatoes (growing in the open)	0.2	3.8	2.8
Other vegetables growing in the open ...	(a)	20.5	15.1
All Crops growing in Glasshouses	3.3	4.1	3.7
All Crops growing in Frames			0.4
TOTAL VEGETABLES (excluding Potatoes)	251.0	543.0	538.5
Hardy Nursery Stock	10.5	6.6	7.9
All Bulb Flowers, not under glass	7.7	2.7	3.4
Other Flowers not under glass	5.8	4.1	4.6
TOTAL FLOWERS	24.0	13.4	16.0

(a) Not returned.

SEASONAL AVERAGE PRICES (WHOLESALE TO RETAILER) OF VEGETABLES (2ND QUALITY ONLY) AT CERTAIN LARGE TOWN MARKETS IN ENGLAND AND WALES FOR THE 10-YEAR PERIOD 1925-34 INCLUSIVE

Description	Weight	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Artichokes, Jerusalem ...	Cwt.	8 0	7 5	8 1	9 2	8 8	7 9	7 8	7 9	7 2	7 9
Asparagus, Worcester (ord.) ...	Bdle.	3 0	3 6	2 3	2 7	2 5	2 2	2 2	2 6	2 7	2 1
Beans, Dwarf, outdoor ...	lb.	1¼	1	1½	2	1½	1¾	2¼	2¼	1¾	2
" Scarlet Runners ...	Cwt.	14 0	7 9	8 4	15 9	14 3	12 0	10 9	13 3	12 9	12 9
" Broad ...	Cwt.	12 9	6 7	9 8	12 9	10 6	8 3	9 6	8 9	10 9	8 7
Beet ...	Cwt.	4 11	4 9	4 8	6 4	4 10	4 2	3 3	6 7	3 9	3 9
Broccoli, Cornish ...	Doz.	2 6	2 0	2 0	3 3	3 3	3 0	2 9	3 2	2 4	3 1
Brussels Sprouts ...	Cwt.	14 9	15 3	13 0	15 6	17 0	15 9	14 3	12 3	11 9	13 3
Cabbage ...	Doz.	1 5	1 2	1 2	1 4	1 4	1 3	1 2	11½	1 1	1 1
" Savoy ...	Doz.	1 10	1 8	1 7	1 9	1 9	1 10	1 6	1 3	1 1	1 9
Carrots ...	Cwt.	4 11	5 11	5 2	6 11	5 4	3 11	4 6	6 9	6 6	6 3
Cauliflowers ...	Doz.	2 11	2 7	2 3	2 9	2 7	2 5	2 3	2 3	2 5	2 2
Celery ...	Bdl.	1 9	1 5	1 6	1 7	1 7	1 6	1 6	1 3	1 2	1 3
Lettuce, Cos ...	Doz.	1 7	1 2	11½	1 3	1 1	1 1	11½	1 1	1 0	1 9
" Cabbage ...	Doz.	1 5	1 1	11	1 2	1 3	1 0	10½	11½	1 0	1 1
Mushrooms, forced ...	12 lb.	23 6	24 6	24 6	27 9	21 6	19 6	18 6	20 6	17 6	14 9
" outdoor ...	12 lb.	9 4	15 9	12 6	12 3	9 9	11 3	13 3	12 6	8 11	7 2
Onions, British ...	Cwt.	8 11	7 2	7 7	10 6	8 7	4 11	6 3	10 9	9 6	5 11
Parsnips ...	Cwt.	5 6	6 6	5 2	5 5	6 9	5 2	4 6	5 3	5 8	7 3
Peas, Market Garden ...	Cwt.	24 6	16 6	17 6	15 6	16 9	16 9	15 6	14 6	17 0	14 3
Spinach ...	Cwt.	18 3	21 0	22 0	21 6	22 6	19 6	16 6	21 0	20 0	15 6
Swedes, Table ...	Cwt.	2 10	2 9	2 8	2 11	2 9	2 5	2 7	2 3	2 5	2 7
Turnips, White ...	Cwt.	4 6	3 8	3 7	4 1	4 3	4 1	3 10	3 9	3 8	4 7
Vegetable Marrows ...	Doz.	1 9	1 11	2 6	2 1	2 6	2 1	2 4	2 1	2 4	1 9
Watercress ...	Cwt.	27 6	29 6	29 6	30 6	31 6	32 6	32 6	30 6	28 6	31 6

Extracted from *Vegetable Marketing in England and Wales*: Economic Series No. 25, Ministry of Agriculture and Fisheries, London, H.M. Stationery Office, Price 1/-.

CHAPTER THREE

Soil, Climate, Irrigation, Composting, Returning Straw to the Land, Artificial Manuring, Tillage

Soils for Vegetable Production. The type of soil should always receive careful consideration when the production of vegetables is the principle object. The capacity of soils to produce good vegetable crops varies very considerably. In the past much land has been used for vegetable production that was really never very suitable for it, and was kept in a productive condition only by means of enormous quantities of cheap town manure. Most vegetable crops succeed best on soils of a lighter texture, such as sandy loams, but it is important that there should be a good depth, at least 8 in., of surface soil, with a reasonable type of subsoil below. The latter point is really important because the productiveness of land is often seriously affected by the presence of an unfavourable subsoil. As examples, a heavy impervious subsoil hinders free drainage and in turn the development of a good root system, while very sandy or gravelly subsoils have the opposite effect because they drain away the moisture too quickly, so that unless irrigation is provided the crops suffer unduly during dry spells.

Soils : Various Types. For a useful working classification soils may be divided into seven types, viz., loamy, sandy, gravelly, marly, peaty, clay and chalky soils.

The *loamy* soil, always the best type for horticulture, is composed of a mixture of sand and clay in varying proportions. If containing from 20 to 30 per cent of clay it is considered as

a light loam, and from 30 to 50 per cent of clay as a heavy loam. The special merits of a loamy soil are that it holds moisture without being impervious, is usually well supplied with mineral elements, is of good structure with a "smooth" texture, and is easily worked at all times of the year.

The *sandy* soil contains, as its name implies, a high proportion (70 per cent and over) of pure sand (silica). Its advantage is that it is easily worked, and, although normally poor in mineral elements, provides a free and warm rooting medium, which can be enriched by manuring with farmyard manure or compost to the point at which it becomes satisfactorily productive. One weakness of a sandy soil is that it does not hold moisture well, and so, together with the gravelly soil, is usually the first to show signs of drought in the crops. This type of soil loses its nitrogen content rather quickly through leaching, but usually responds quickly to applications of this element. A sandy soil may be calcareous or non-calcareous ; if it is the latter, it may tend to develop sourness and an infertile condition so that routine cultivation calls for regular applications of lime.

The *gravelly* soil, like the sandy soil, tends to contain too much of one constituent—in this case small stones or pebbles. Such a soil frequently originates from old river beds and glacial drifts usually superimposed on the basic rock. Although perhaps one of the least useful of soils for horticultural cropping because of its low level of fertility, it is a warmer type of soil than many and is thus useful for early production.

Marly soils contain a fair proportion of calcium carbonate (up to 20 per cent) in addition to clay. They thus tend to be sticky and heavy in working, rather expensive to keep supplied with organic matter, and in texture are of a close pasty character. They are not naturally fertile and tending to be cold are of secondary interest for horticulture.

The *peaty* or "muck" soil contains a high proportion of partially decomposed organic matter, and is often of an acid character. The whole structure of such a soil is unbalanced, but when limed and treated with fertilizers it is good for some horticultural crops, particularly celery and carrots.

Clayey soils are usually so-called when they contain over 50 per cent of clay. There is, however, a considerable variation in this type of soil owing to its origin. To give examples, there

FIG. 8.—Hoeing a field of Parnsips by "crawling."

Handwork still plays an important part in vegetable growing.

FIG 9.—Mechanical Cultivation. The small *Planet* hoe

FIG. 10—Mechanical Cultivation. The smallest motor-driven hoe—the *Auto-Culto.*

ON MANY FARMS, ROW CROP CULTIVATION IS DONE BY MACHINES.

FIG. 11.—Mechanical Cultivation. The *Farmall* tractor and cultivator at work in a field of Cabbage.

are the Oxford and Gault Clays, which are very difficult to work, are cold, and of a texture that renders them subject to waterlogging and difficult to drain. Such soils are of little use for horticulture, though the Weald and Kimmeridge clays can apparently be used with success for fruit crops, as witness the Lower Weald of Kent—a famous region for orchards. The Boulder Clay and Clay-with-flints are other examples of clay soils that, although cold and badly aerated, can be turned to good account for vegetable crops of certain types, much, however, depending on the character of the sub-soil. Boulder Clay and Clay-with-flints often have chalk below, which keeps them well drained. The special advantages of a clay soil are derived from its moisture-holding capacity and other forms of surface activity together with the natural store of potassium it usually contains, all important factors from the point of view of vegetable and fruit growing. On the other hand, nitrate formation is handicapped when clay soils become wet or badly puddled. Clay soils are the most difficult to cultivate.

A *chalky* or *calcareous* soil is formed as a rule over the true Chalk formations and contains more than 20 per cent of calcium carbonate. It may be purely calcareous, *i.e.* without any appreciable admixture of clay or sand, or it may contain a sufficient proportion of clay or sand substantially to affect its character. Soils of this type require careful examination and consideration before being used for horticulture, but there are many examples that have been shown to be productive of many kinds of crops when well managed.

The factors contributing to natural soil formation are first of all the character of the underlying rock from which the soil is formed ; second, the climate that acts on the rock ; and third, the natural growth, whether herbage, scrub or forest, which the soil produces. The rocks break down to form sandy, clayey or chalky material in the first place, and this may remain *in situ*, so forming a typified soil, or may be transported by water (floods and rivers) or ice (glaciers) to form alluvium and surface "drifts" respectively. Climatic conditions, by weathering the rock to particles of varying degree in size, influence the type of soil ultimately formed. The natural herbage provides organic matter, and by covering the surface conserves the soil by preventing erosion by wind and rain.

It has been explained that soils vary not only in the character

of their constituents but in their structure. While structure depends to a certain extent on the proportions of clay, sand and silt present in the soil, it is considerably influenced by the amount of organic matter and lime present and is also directly affected by tillage and cropping operations. Organic matter performs an important function in assisting the soil to retain moisture and in maintaining an open porous condition so that plant roots move and develop freely. By its physical and chemical action in the soil organic matter promotes reserves of plant food, which are gradually made available by the soil organisms or by chemical change.

A soil that contains suitable proportions of sand, clay, organic matter and lime, however, although potentially fertile, still requires water to render it serviceable for crop production. At the same time, water in excess, *i.e.* beyond the field capacity point, is not desirable, and often one of the greatest problems in connection with the use of land for crop production is concerned with securing adequate drainage. Apart from the amount taken up by crops and weeds, water is removed from the soil by evaporation and by drainage, but it moves comparatively slowly through some types of soil, notably heavy clays, so that it is often difficult to free them of surplus water. On the other hand, the water supply may be insufficient for the cultivated crop's requirements, and then irrigation—a practice successfully used in many parts of the world for both fruit and vegetable crops—must, if possible, be resorted to. (See irrigation, page 52).

Waterlogging, however, may easily become a problem, because air is necessary to root life and development, and waterlogged soils contain little or no air. In the absence of air the roots are unable to breathe and absorb plant nutrients and the plants either die or develop a sickly condition. Fruit growers are familiar with the symptoms exhibited by trees growing on waterlogged soils, the condition being known colloquially as "the death."

Much can always be gleaned about the character of a soil by a study of the local vegetation, and although noxious weeds can usually be eradicated by adequate tillage it is always advisable to note whether any particularly troublesome weed is present in abundance. Bad weeds for the vegetable grower are hoary pepperwort (chalk, or Thanet weed), perennial

thistles, wild convolvulus (especially the larger form), wild onion and couch grass, although the last named is more easily controlled by good tillage than the others.

The general contour of the land is always important, a fairly level or gently undulating type being the most suitable, particularly for the employment of mechanized tillage. Land forming frost-holes should be avoided, as early crops are apt to be cut off, and overwintering crops suffer badly, in such situations. Rhubarb, for example, if grown in a frost-hole is always appreciably later than on higher situations, although it may appear to be protected naturally. On cold nights in the spring high lying land is warmer—other things being equal. But exposed situations subject to the effect of wind should also be avoided. Steep hillsides sloping south or south-west are often warm and early, but slopes can constitute a serious problem from the angle of water erosion, the loss of soil, as is seen in the Tamar Valley, often reaching serious proportions.

The official Soil Survey reports, for those areas where such surveys have been carried out, are always very helpful to the enquirer for land suitable for both fruit and vegetables. They should be studied carefully.

Climate. Because climate, which involves temperature, humidity, rainfall and sunlight, is an important factor in the growing of vegetables, some knowledge of the climatic conditions is essential. In some areas of England the growth of crops is often seriously influenced by insufficient rainfall at important seasons of the year, particularly in the early summer when seedlings are in the crucial stage or vital transplanting work has to be done. A rainfall approximating 30 in. per annum, evenly distributed, is best suited for all-round vegetable production. In the Eastern counties the figure is usually nearer 20 in. and because of that soil moisture is often a controlling factor in crop growth. On the other hand, excessive rainfall is a drawback, and may often ruin crops such as peas, beans and onions. The latter crop is uniformly successful in the drier districts. Some crops prefer a cool climate, others a warm.

Frost is another climatic factor that influences production. Crops that over-winter, such as broccoli, winter lettuce and autumn-sown peas and beans, are very speculative in districts where winters are severe. Spring cabbage and spring onions

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are often badly damaged by severe weather during the winter. Growers who wish to specialise in such crops should seek the most favourable climatic conditions. Late spring frosts are a menace to tender crops such as potatoes, beans and tomatoes. It is well to remember that land in the vicinity of water (*e.g.* seaboard districts) enjoys a milder climate than inland areas, although wind may often counter-balance the advantage gained.

Systems of Irrigation. Since soil moisture plays an all-important part in vegetable production, and water supplied as rain is dependent on the vagaries of the climate, it was to be expected that an important aspect of modern development would be the increased attention paid to systems of soil irrigation or watering. During the last ten years modern watering systems have been finding their place as normal equipment of the market garden thus bringing crop production under closer and more positive control despite the weather.

There are three ways of watering the soil : (1) by flooding (land irrigation) ; (2) by low pressure overhead sprinklers and specially designed "rainers", and (3) by either low or high pressure pipe spray lines.

Land irrigation by flooding, using the furrow system, is little practised in Britain for the watering of crops. It is, however, successfully used in France, notably in the Seine Valley near Paris. Perhaps the most interesting development is the portable oscillating spray line running a few feet above ground level. This spray line, which is of coupled-up lengths of piping with spray jets at short intervals, from 100 ft. to 100 yards long, and is rotated back and forth by hydraulic mechanism.

By this means water to the equivalent of ¼ in. of rain per hour can be evenly distributed over a rectangular area of about 40 ft. wide and the length of the spray line. As such spray lines use from 500 to 600 gals. of water per hour per 100 ft. length, it is obvious that this type of watering system calls for an adequate and unfailing supply of water. Low pressure pumps, say to 80 lb. pressure, can be used with this system.

The specially designed "rainer" can also work with pump pressures between 50 lb. and 100 lb. per sq. in. The "rainer" (Fig. 45) is a type of spray gun giving either a short or long range jet, rotating at the same time. It will effectively water all the

soil within a given radius. While petrol and oil engines are commonly used for power it is useful to know that a *Fordson* tractor will give ample power for operating the pumps for these systems.

Sigmund Field Rainmasters (see Fig. 45) are built in three sizes—No. 2, 3 and 4. No. 2 Rainmaster will spray up to one acre in one setting, and is generally used in installations covering up to about 40-80 acres. No. 3 covers one and a half acres, and is for installations between 60-180 acres, and No. 4 irrigates up to two and a half acres at once, and is for very large installations and with less delicate crops, such as grass land.

The system of low-pressure sprayline irrigation, most commonly used by vegetable growers, is considered to be the nearest approach to natural rain. The sprayline consists of very light galvanized steel pipes of standard length (16 ft.) coupled together to give a required continuous length, up to a maximum of about 300 ft. to irrigate ¼-acre of land. The number of nozzles per length varies, usually either 8 or 12, and the water which is pumped into the sprayline to feed the irrigation also drives a patent oscillator, which controls the regular left and right movement of the sprayline. Thus at the pressures used, about 35-45 lb. per sq. in., there is no puddling of the soil as the water falls intermittently on the same spot. The total width covered by each sprayline is 50 ft. (See Fig. 46).

It is clear that systems of watering will play an increasing part in the vegetable production of the future. For further information readers are referred to firms of water supply engineers which specialise in irrigational work. For further information see the Section of this chapter: "Why are crops cultivated?" (p. 77).

Composting. During the last ten years the art of compost making, as a means of meeting the shortage of stable and farmyard manure, has developed considerably. Many vegetable growers are now making compost, utilizing in the process both straw and waste vegetable matter. Some growers go to the extent of purchasing straw especially for the purpose of composting. Useful composts are also being made by local authorities from house refuse and sewage sludge.

Compost making is a simple process, being based on the fact that when vegetable matter, air and water are brought

together in suitable proportions fermentation ensues and the whole mass decomposes. The decomposition can be speeded up by using an "accelerator" which may either be animal manure or sewage sludge, on the lines of the Indore process, or chemical substances on the lines of the Adco process. (See page 318).

A well made compost not only provides the soil with plant foods, but, by contributing valuable humus-forming material, improves its tilth, temperature, water-holding capacity, drainage, and its physical condition generally. Compost, then, is a suitable and effective alternative to farmyard or stable manure, but is not a perfect substitute (see following Section).

Returning Straw to the Land. The benefit obtained from straw whether partly rotted (as in long straw manure) or thoroughly rotted (composted) is mainly due to its effect on the soil's physical condition, *i.e.* its structure.

It is well known that the heavier types of soil respond to the opening-up effect of pieces of partly rotted straw found in strawy manure; this applies particularly to land under root crops. The straw also renders the soil easier to work. On the other hand, the organic matter occurring in well rotted (short) farmyard manure appears to be particularly beneficial to light soils, for it increases their capacity (which, normally, is low) to retain both moisture and crop foods.

Apart from its physical effects straw does contain an appreciable amount of plant foods which ought, if possible, to be returned to the soil from whence it came. Calculations based on the average composition of cereal straws indicate that an average straw crop of 30 cwt. per acre removes from the soil about 0·15 cwt. of nitrogen, 0·06 cwt. of P_2O_5 and 0·3 cwt. of K_2O. (The last figure for potash, corresponds to the standard dressing used in the 1944/45 season as the basis of permits for potash fertilisers for sugar beet, mangolds and beans). The amount of potential crop nutrients in straw, though not high, is thus worth taking into account in considering whether the effort involved in returning the straw to the land is justified. These nutrients are tightly bound up with the relatively inert carbohydrates of the straw and do not pass into forms that crops can utilize until the carbohydrates have been broken down by allowing the straw to rot.

When the straw is kept moist and air is allowed free access, fungi and bacteria break down the carbohydrates portion of the straw, but the activity of the organisms is limited by the amount of nitrogen they are able to obtain from the straw. As the rotting process proceeds the straw loses bulk and is broken down into a residue containing organic matter that is in a more active form than that in fresh straw, and richer than the latter in available and total nitrogen, phosphate and potash. If, on the other hand, the nitrogen in straw is supplemented by supplying nitrogen in a simple form, *e.g.* in the form of sulphate of ammonia, the rotting process is considerably hastened. It has been found that 100 parts of straw containing about 0·5 parts of nitrogen require about 0·75 parts of additional nitrogen for rotting to proceed effectively. In composting straw with sulphate of ammonia it is generally recommended that each ton of fresh straw should receive 1 cwt. of sulphate of ammonia and (in order to neutralise acids that would interfere with the activity of the organisms decomposing the straw), 1 cwt. of ground limestone and about 800 gallons of water. Alternatively, 1 cwt. of calcium cyanamide may be used instead of the sulphate of ammonia, and then the addition of ground limestone is unnecessary. The compost may be made in heaps without side protection or in pits. Straw properly composted loses about 40 per cent of its organic matter in a few months and rots down to a product similar in physical properties to ''strawy'' farmyard manure. (See page 318).

Trials at Rothamsted are being carried out with straw applied in the form of composts made with sewage sludge instead of sulphate of ammonia. This type of compost, unless left for some months to mature, behaves similarly to strawy manure and temporarily deprives the soil of much of its available nitrogen. Sludge composts are being tested mainly on rotations of market garden crops, and some evidence has already been obtained to support the view that, apart from the nutrients provided by the sludge, market garden crops benefit through the improved properties and water supply. Most of the sludge-straw composts so far tested have been made partly from dried sludge from the drying beds, but alternative types made from liquid sludge and straw are also being tested.

Fresh straw when ploughed in undergoes a similar rotting process, but the additional nitrogen required by the organisms

is taken from the stock of available nitrogen already in the soil. Although in autumn this may conserve nitrate that would otherwise be lost in drainage, in spring the loss of available nitrogen may reduce crop yields unless additional nitrogen is supplied with the straw or to the following crops. The rotting of ploughed-in straw can be speeded up, in the same way as in composting, by adding sulphate of ammonia to it ($\frac{3}{4}$-1 cwt. per ton) at the time of ploughing-in, preferably, when it is available for immediate utilization by the crop. This was well demonstrated in the experimental work on the manurial value of straw carried out at Rothamsted.

In general practice the rule should be that as long as artificial nitrogen is given, ploughed-in straw is beneficial and that the ploughing-in of straw provides an inexpensive means of disposing usefully of straw during normal tillage operations. On the other hand, the composting of straw involves high labour costs for preparation, turning and spreading, and if the following crop is to benefit additional dressings of nitrogen will have to be given to make good the temporary losses of available nitrogen resulting from the further decomposition of the straw in the soil. In other words, it may pay to use relatively heavy applications of nitrogen in conjunction with ploughed-in straw.

Ploughing-in of straw should not be regarded as an alternative to or substitute for farmyard manure but a method of making use of surplus straw despite the fact of the mechanical difficulties in ploughing-in. Cereal straws vary in the ease with which they can be ploughed-in. Barley and pea straw (though the latter is rarely ploughed-in) are easier to deal with than rye and wheat straw. In practice it is sometimes possible to arrange that in ploughing-in straw only barley straw is used.

Artificials. A word on the use of so-called artificial fertilizers is necessary. The use of these substances as a means of maintaining the soil in a productive condition by supplying nutrient elements which may be in short supply in the soil, has now fully a century of practical experience behind it. In recent times views have been advanced to the effect that the use of such fertilizers is not only a false practice, inimical to the well being of the soil, but that the plants grown with them are more susceptible to attacks of disease and pests, and the food produced with their aid has an inferior nutritional value. It is safe to state that the

majority of soil scientists can see no grounds for these views. There is nothing harmful to soil fertility in the judicious use of fertilizers, and the other views lack experimental proof.

At the same time all schools of thought agree that the maintenance of soil humus is important from several points of view, and in this the application of stable and farmyard manure and well made composts, the use of grazing animals, such as sheep, the employment of short leys, and the ploughing-in of green crops must all continue to play a part.

The Principles of Manurial Treatment. Few growers to-day can hope to succeed with vegetable crops without some knowledge of the science of plant growth, the principles of soil fertility, and the practical application of soil chemistry to farming practice. It is hopeless to follow blindly the footsteps of others; instead, each grower should be well acquainted with the character and composition of his own particular soil, or soils, their requirements and the special needs of the crops he raises on them.

While it is very important to realize that crops vary in their element requirements, in the production of vegetable crops the use of a complete fertilizer, such as a mixture based on the 1-2-1 analysis ratio, is nearly always justified. But although a fertilizer may be complete in the sense that it contains units of nitrogen, phosphates and potash, the analysis of fertilizer mixtures should vary not only according to the crop grown but according to the soil. Occasionally, however, for such crops as peas, beans and carrots, a phosphate-potash fertilizer will yield adequate results without the inclusion of nitrogen. In the old days when much town stable manure was applied to the land, and the intelligent use of fertilizers was little understood, it was probably the case that many crops were insufficiently supplied with phosphates. It is estimated that a ton of horse manure (excrement) contains 14 lb. of nitrogen, 5 lb. of phosphoric acid, and 11 lb. of potash. A ton of wheat straw bedding contains 11·5 lb. of nitrogen, 4·4 lb. of phosphoric acid, and 12·6 lb. of potash. Stable dung being composed largely of both these materials, it becomes clear that the ratio of phosphoric acid to both nitrogen and potash in this type of manure is very low, too low in fact for most vegetable crops. The practice of adding 18 per cent superphosphate to farmyard

and stable manure, at the rate of from 50 to 100 lb. to the ton, has much to commend it—otherwise the phosphate should go on as a supplementary application to secure a better balance in the dung application. It is now generally realized that for crops requiring farmyard or stable manure it is possible to secure better results by using half the amount of dung and supplementing with from 500 to 1,000 lb. of a complete, high-analysis fertilizer according to the crop. Complete fertilizers of high analysis should contain a total of at least 14 units of plant nutrients. Thus a 5-10-5 fertilizer would constitute a high-analysis mixture—in other words, each 100 lb. contains 5 lb. nitrogen, 10 lb. phosphoric acid and 5 lb. potash, a total of 20 units.

Most of the commercial fertilizers on the market at the present time are composed of "straight" substances of mineral origin, usually sulphate of ammonia, superphosphate and either muriate or sulphate of potash or potash salts. These are so mixed, with the addition of a filler to keep the whole in a friable condition, as to give varying analyses. Extravagant claims are sometimes made, and high prices are often charged, for proprietary fertilizers that are said to contain some organic substance that forms a better source of fertility than the inorganic materials already mentioned. While tankage, hoof and horn meal, fish meal and Peruvian guano are all substances of value, the grower must guard against being asked to pay too highly for their inclusion in fertilizer mixtures.

Another useful type of commercial fertilizer is the concentrated granular type of compound. It can be very effective in use, and is easy to handle.

Money can be saved by mixing fertilizers at home, but it is often worth an extra £1 or 10s. per ton to buy a compound fertilizer that is properly made or mixed and in good condition for distribution. By using the unit system of valuation the grower can always make certain that he is not paying too high a price for his major mineral elements.

To sum up, therefore, the vegetable grower must always be able (*a*) to choose the fertilizer materials; (*b*) to determine the formula to be used; and (*c*) to calculate the amount required per acre and its cost. The important point is to avoid putting on a greater amount of fertilizer than the cash value of the resultant crop can be expected to carry ; at the same time it is

true economy to ensure that there are sufficient plant nutrients for its needs.

The Raw Elements of Growth. Brief reference must be made to the fact that the raw materials of plant growth are not entirely a matter of nitrogen, phosphates, potash and water. At least twelve elements, viz., carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, iron, calcium, magnesium, sulphur, manganese, boron, and, it is thought, zinc and copper are essential to healthy growth, and all but the first three are normally derived from the soil. Some crop plants, beet for example, appear to make use of sodium as well, and can use it as a substitute for potash, hence the practice of applying salt. As the plants make use of larger amounts of the six elements nitrogen, phosphorus, potassium, calcium, magnesium and sulphur, these have come to be regarded as *essential major elements*, while iron, manganese, boron, zinc and copper, being used in smaller amounts, are regarded as *essential trace elements*.

The advance of science applied to horticulture has enabled many troubles, formerly of an obscure character, to be related either to major element or trace element deficiencies. An example of the latter is the leaf distortion and browning, or non-development, of the curd in cauliflowers, and the brown heart disease of beet, turnips, and other root crops, which is due to boron deficiency.

At the end of this book (Appendix II) is a list of materials available to the vegetable grower for fertilizing purposes, together with an example of how a complete fertilizer of a stated analysis may be prepared at home.

Farmyard and Stable Manure. Before leaving the subject of fertility something should be said on the subject of organic manure and its uses. Admittedly, it is impossible to maintain land in a good condition indefinitely by means of commercial fertilizers alone. Substances sold as fertilizers, whether organic or inorganic, do not contribute substantially to the organic matter content of the soil. In the absence of organic matter the soil will not only decline in quality and natural fertility, but its drought-resisting and drainage capacity will be impaired. All land devoted to vegetable growing will sooner or later require applications of farmyard or stable manure, or, failing that a

good compost such as that obtained by the Adco and Indore processes. While green manuring may be a useful compromise it cannot wholly replace farmyard or stable manure.

It is, therefore, very difficult to see how the vegetable grower of the future will be able to carry on without maintaining livestock either for the purpose of making farmyard manure, or for supplying animal manure for composting straw and other waste matter. This is where the mixed farm type of producer enjoys a distinct advantage. While it is, of course, possible to break up old pasture and carry on without the use of manure for several seasons, making use of fertilizers, ultimately even this type of land will lose "heart" and decline in value if no organic manure is used.

So valuable and indispensable is manure obtained from bedded livestock that many large vegetable growers are now maintaining bullock yards and piggeries with the main object of making manure. While the fertilizing value of manure varies according to the feeding of the livestock, it also varies according to the kind of animal kept. As will be seen from the following table, horse manure is the most valuable if it is properly made and stored. Unlike pig and cow manures, which are classed as *cold* manures, horse manure is a *hot* manure and is apt to overheat, with a consequent loss of ammonia value. It should be turned frequently and, if necessary, watered, or (better still) mixed with cow or pig manure.

While the type of feeding of the livestock affects the quality of the manure made by the animals it is important to realize that only part of the fertilizing value is retained. Part of the plant nutrients carried by the food is utilized by the animal, but there may be further serious losses after the manure is made. On earth floors, for example, both nitrogen and potash are lost by the drainage that is avoidable on concrete floors. Further losses are incurred if the manure is exposed to the elements after removal from the yard or pen. As the correct making and conserving of manure is of fundamental importance the manure once made should always be stored in a properly-constructed dungstead provided with a good roof, so that rain cannot wash out its valuable elements.

Organic versus Inorganic Fertilizers.

The points of supreme interest to the vegetable grower to-day

are methods of adding organic matter to the soil, and the extent to which organic matter as a source of plant nutrients may safely be replaced by inorganic fertilizers. The fundamental difficulty is concerned with the separation of the physical effects of organic matter from its value as a source of nutrients. Organic matter in terms of humus is undoubtedly of prime importance to the soil because of its influence on texture, the regulation of moisture, aeration, temperature, amount of carbon-dioxide and colloidal activity, with which is associated the base exchange chemical action. As humus breaks down, nitrogen, phosphorous, potassium, sulphur, calcium, magnesium, manganese, zinc, copper and boron are all liberated and made available to growing crops. Soils depleted of humus lose their spongy or granular structure, and under the conditions of cultivation and exposure to weather run together like cement and are more easily affected by the forces of erosion—wind and water.

In modern market gardening practice, irrigation systems largely solve the soil moisture problem and adequate implement cultivations deal with soil aeration. Granted that soil humus is maintained by the regular application of farmyard or stable manure or compost, mineral fertilizers are equally as reliable as organics, such as hoof and horn, meat meal, fish meal, and dried blood, as a source of plant nutrients. Moreover, the trend of available information indicates that organic sources of plant food are less effective and less rapid in action than the inorganics. The ideal manurial practice in market gardening aims at supplying the nutrients in a rapidly available form in the right amounts and at the time when they are most needed by the crops. This can satisfactorily be done with inorganics though their effect is closely bound up with soil moisture. This raises the questions of *fertilizer placement* and the best times for application. The usual practice of broadcasting fertilizers on the surface and cultivating or hoeing them in is probably the best for shallow-rooting crops, but for deep-rooting crops it is possible that better results would follow the placing of fertilizers by means of drills or other adapted inplements. Fertilizer placement, by inserting the nutrients below the surface in contact with moist soil, would probably be the best method of top-dressing in drier districts.

As bearing on the controversial subject or organic versus inorganic fertilizers, it is worth noting the wide difference in rates of application usually to be found. Growers have no hesitation in using from one to two tons of soot or from 10 to 15 cwt. of hoof and horn, meat meal, etc., per acre, often equivalent to 5 to 8 cwt. of ammonia. Against this usage the average amounts of inorganic nitrogenous fertilizers applied are such that only about a quarter or one third of the nitrogen available in the inorganics is supplied. Insufficient appreciation of this point may partly be responsible for the general preference for the organic manures.

There appears to be a general lack of knowledge on the part of growers of the value, in terms of plant nutrients, of organic fertilizers. It is also a common assertion that organics have a better residual effect than the inorganics. It is quite safe to say that the little experimental evidence available does not support the view that there is any difference on the basis of residual effect. On the other hand, the soil nitrifying bacteria will work on ammonium salts and substances of the hoof and horn type with equal facility, so that, as one might expect, the "end product" is the same in both instances.

What probably occurs under the average market gardening practice is that there is a wastage of nitrogen both by leaching and liberation in a gaseous form. With the large amounts of vegetable, strawy and other organic matter commonly used by market gardeners, large quantities of nitrogen are required for their effective bacterial decomposition. This is turn may account, at least part y, for the heavy dressings of nitrogenous inorganics. The conclusion to be drawn is that the use of nitrogenous organic matter as manure could be reduced through the use of adequate cultivations, liming and irrigation.

Finally, it should clearly be understood that this section is not dealing with the organics such as farmyard and stable manure and well made composts, but with the substances commonly termed organic fertilizers. The former are clearly essential as contributors of humus to the soil, which remains primarily a living functioning system still imperfectly understood. What is not conceded is that "organics," as understood in the fertilizer term, possess any superiority over "inorganics" as a source of plant nutrients.

The Virtue of Animal Manure.

It is reasonable to raise the question of whether stable and farmyard manure, i.e. animal manure, possesses any special virtue. It is now known that the growth substances commonly termed growth hormones were obtained originally from the urine of pregnant mares. These growth substances (they are now made synthetically) exert a definite influence on root development and in association with minor elements—iron, copper, manganese, boron, molybdenum, iodine—similarly available from animal manure, it is a fair supposition that this type of manure does possess virtues of a particularly valuable kind. It is possible, therefore, that the increasing number of problems associated with minor nutrient element deficiencies may partly be due to the decreasing use (through non-availability) of animal manure.

Apart from the foregoing considerations the manure derived from animals is a valuable commodity not only as a source of humus but as a source of major nutrient elements.

Table showing Average Amounts, in pounds per ton, of Mineral Elements contained in different kinds of Bedding and in Solid Excrement of different Animals.

Animal or Bedding.	*Nitrogen.*	*Phosphoric Acid.*	*Potash.*
Horse	14·0	5·0	11·0
Cow	12·0	3·0	9·0
Pig	10·0	7·0	8·0
Sheep	19·0	7·0	20·0
Fowls	20·0	16·0	8·0
Wheat Straw ...	11·5	4·4	12·6
Oat straw ...	11·0	5·6	15·4
Peat	4·0	4·0	2·0

Because of the amount of plant food constituents retained by the animal it may be taken as a general rule that the best manure for vegetable growing is that obtained from working animals, e.g. horses, while that from meat animals, e.g. bullocks and pigs, is the next in value, and that from milking cows the lowest.

Farmyard or stable manure should always be ploughed under with the least possible delay; it is a mistake to leave it standing in small heaps or spread on the land, waiting for the plough.

Vegetable growers may desire to know the amounts of manure obtainable from various livestock. The actual tonnage of dung made will naturally vary according to the quantity of bedding supplied. Some idea of the capacity of animals to make dung may be gathered from the following table :—

Production of Liquid and Solid Excrement per day and per year : Units of 1,000 lb. live weight.

Animal.	*lb. per day.*	*tons per year.*
Horse	50	9·1
Milking Cow ...	70	12·7
Bullock	41	7·5
Pigs	82	15·0
Sheep	33	6·0
Fowls	23	4·0

From the foregoing table it will be noticed that, weight for weight, pigs are the best manure makers.

Vegetable growers who keep proper accounts (and all growers should maintain a satisfactory system of book-keeping) will desire to credit their livestock with the value of manure produced and charge it against crop production. The following table is sufficiently accurate to enable an estimate to be made of the normal-time value of manure produced by various types of livestock :—

Approximate Amount of Manure produced per annum by various Animals : Units of 1,000 pounds live weight.

Animal.	*Manure in tons.*	*Approximate value per ton.*
Horse	12·1	10—12s.
Cow	14·6	8—10s.
Pig	18·2	8—10s.
Sheep (no litter) ...	6·0	—
Fowls (no litter) ...	4·0	Dry 60s. Wet 30s.

Note : A ton of horse manure contains approximately 10 lb. of nitrogen, 4 lb. of phosphoric acid and 10 lb. of potash.

While it is not fair to use the bare mineral element value of manure as a basis of comparison with commercial fertilizers, because of the greater cost of putting the manure on the land, it should be borne in mind that the most important value of manure lies in its capacity for improving the land—in other

FIG. 12.—A plant breeder at work.

MODERN PLANT BREEDING CALLS FOR SCIENTIFIC METHODS.

FIG. 13.—The cage in which plants are grown for seed in complete isolation.

FIG. 14.—An improved type of Brussels Sprout Bred at the Cambridge Horticultural Research Station.

FIG. 15.—An example of a modern market broccoli for March-April cutting. Variety "Monarch." Note *round* compact heads and protective foliage.

words, maintaining the land in good heart and in a fertile biological condition.

Soil Acidity. Although problems concerned with acid humus soils, in which abnormal amounts of carbonic acid have accumulated, occur not infrequently, soil acidity is generally not due to the presence of loose and appreciable amounts of acid substances, such for example, as hydrochloric acid, nitric acid, for these would be easily washed through the soil by rain and give little trouble. The soil acidity with which the cultivator is chiefly concerned is that associated with the clay in the soil, the colloidal particles of which carry exchangeable *cations* of base elements. Clay is the active constituent of all soils, and in relation to soil acidity the colloidal particles of clay hold the bases as adsorbable *cations*, *i.e.* in an easily ionizable form.

When the clay particles are holding the maximum amount of exchangeable *cations* of alkaline elements, such as calcium, magnesium, potassium or sodium, or a mixture of them, the soil is said to be *saturated.* It has then no acidity and is often spoken of as being "sweet"—a term, however, that is incorrect and means nothing, though it is taken to be opposed to sour or acid.

The ions of these exchangeable base elements, however, become loosened from the surface of clay particles to which they are attached (adsorbed) and are washed (leached) out, and so are lost to the soil. It is then that the acid element, the hydrogen ions from the soil carbonic acid, which are loose in the soil, become attached (adsorbed) to the clay particles in place of the lost alkaline ions. This process proceeds until sufficient alkaline elements have been removed and replaced by hydrogen ions to impart to the soil a degree of acidity. It is then said to be *unsaturated.* The concentration of hydrogen ions is measured by soil chemists in terms of the pH scale.

The strength or intensity of acidity may be likened to wire netting—the smaller the mesh or gauge number the heavier the wire. The gauge of soil acidity concerned with hydrogen-ion concentrations is called the pH scale and the smaller the number of the pH evaluation the stronger the acidity. Thus a pH of 4·0 is reckoned the extreme of acidity for any soil, while a pH of 7·0 is neutral and above that value the soil becomes by degrees more alkaline until it may contain calcium carbonate, *i.e.* lime,

or other alkaline substances in appreciable amounts. Very few plants will grow in soils below pH 3·5 or above pH 9·0—certainly no crop plants.

The point of practical interest to the grower in this rather complex matter is that while pH values indicate the strength of acidity they tell us nothing about the amount. It is, however, comparable to the intensity and quantity of heat, temperature being strength and calories the amount. Since the main acid factor in normal soils is the clay particles it follows that the amelioration process will vary according to the proportion of clay in the soil. In other words, soils can have the same pH value yet differ widely in the lime requirements to effect a change. In farming practice it means that the amounts per acre of applied lime are considered in terms of the absorptive capacity of the soil, the point being that a heavy soil containing much clay will need considerably more lime to reduce its acidity than a sandy loam containing a low proportion of clay. For example, it might be said that a loamy soil containing 24 per cent clay would need twice as much lime to obtain the same effect as a lighter soil containing only 12 per cent of clay. Thus in practice we say that a clay soil needs twice as much lime as a sand to obtain a given effect.

It is also inportant from the practical standpoint not only to get to know the reaction of various crop plants to particular hydrogen-ion concentrations in cultivated soils but to know the optimum range of pH conditions for each plant.

The original work of the Swedish soil chemist, O. Arrhenius, assisted us considerably in this direction. As a result of growing a large number of farm and market garden crops in soils of varying pH values he ascertained that there is apparently a pH range for each particular crop plant. Such findings, while not to be held applicable to all conditions, are a useful guide for practical purposes. Our range of knowledge of this important subject has recently received a useful contribution from the pen of Professor James Small.

Sourness of soils is usually superficially evident if somewhat complicated in diagnosis. Absolute crop failures, presence of crop diseases, such as Clubroot in the Brassicas, or growth of certain weeds usually accompany marked degrees of soil acidity. Exact information as to lime requirements, however, can be obtained only by laboratory examination, but there are

rough-and-ready types of field test for soil acidity on the basis of chemical reactions. The laboratory examination is, however, the safest and most satisfactory guide to a soil's condition.

Acid Soils. It is known that some crop plants growing on acid soils of a pronounced character tend to develop symptoms of growth injury. The possible factors concerned may be stated as follows :—

1. Direct injury of hydrogen-ions.
2. Lack of available nutrient calcium.
3. Lack of available nutrient phosphorus.
4. Excess of soluble aluminium.
5. Excess of soluble manganese.
6. Inhibited action of nitrogen-fixing bacteria.
7. Inhibited action of other biotic activity, *e.g.* soil mycorrhiza.

Wallace and his co-workers at the Long Ashton Station have discovered the importance of manganese toxicity to crop plants of runner beans and cauliflowers. Characteristic visual foliage symptoms caused by manganese toxicity, namely intervenal chlorosis and necrotic spotting in the beans and incurled leaf margins in the cauliflowers, have been shown to be interdependent on the calcium status of the soil. A point of special interest emerges from this investigation, viz., the factor of inter-relationship that appears to operate with many of the major and minor nutrient elements in relation to the general physiology of plant growth and functioning. As regards the effect of soil acidity on nitrogen-fixing bacteria, it is known that maximum action of these organisms takes place between pH 6·5 and pH 7·8. There is little activity below pH 6·1. It also begins to decline again above pH 7·8.

Field Tests for Soil Acidity. While, as mentioned above, the exact calculation of soil acidity is a matter for laboratory method (the electrical, or pH meter method is usually employed) an approximate calculation is possible by means of field tests making use of special colour solutions or reacting chemicals. One of the simplest methods involves the use of a solution of bromo-thymol-blue and methyl-red. A small quantity of this solution is mixed in a porcelain dish with a small amount of

soil and if the latter be acid a reddish or orange colour results in the liquid ; if non-acid a blue or bluish-green colour results.

Another test is made by placing a small quantity of soil in a test tube and adding a small amount of an alcoholic solution of potassium thiocyanate. The solution colours red if the soil lacks lime. The old and much used field "fizzing" test made by adding hydrochloric acid to the soil is not a sound method of evaluating soil acidity, although it is a useful but rough test for the presence of free lime in the soil.

The Use of Lime. While most vegetable crops are tolerant of a moderate amount of soil acidity, excessive acidity must be guarded against by application of lime from time to time. On a general purpose farm, where the whole range of commercial vegetables are grown, it will be found possible to apply the lime in the rotation for those crops, such as peas and beans, which stand in most need of an alkaline soil.

Although most of our crop plants are said to require small amounts of the element—calcium, lime as calcium carbonate cannot be regarded as a true fertilizer. Its chief value lies in its function as a soil improver and conditioner, particularly its marked power as a flocculating agent on heavy soils difficult to work, and in the fact that most commercial fertilizers are not so effective on soils deficient in lime. The aim of the grower should be to maintain his land either at, or slightly below, the neutral point. Soil acidity is described as slight, moderate, medium and strong. A neutral soil, that is one neither acid nor alkaline, is usually evaluated by the expression pH7. It is considered that most vegetable crops are tolerant of moderate soil acidity expressed as pH6, while a few, notably potatoes, tomatoes and vegetable marrows, are tolerant of a medium acidity expressed as pH5·5. With regard to potatoes, degrees of soil acidity less than pH5 are usually associated with attacks of scab.

It is just as important to guard against over-liming the soil as to neglect the subject until a high degree of acidity has developed. Under normal conditions, where an average loss of lime through leaching and chemical reaction takes place, the application of one ton of ground limestone or ground chalk per acre every four or five years should be sufficient. The material used should always be finely ground. The price factor,

which includes the cost of carriage, should be carefully considered when deciding the type of lime to apply. Under some conditions it may be more economical to apply hydrated lime.

Facilities are now provided throughout the country whereby all growers can obtain expert opinion from the National Agricultural Advisory Service on such problems as that of liming the land. It is much wiser to take advantage of this service, which is free, than to apply lime in a haphazard or extravagant manner.

Tillage : General Principles. It has been stressed that efficient tillage by means of modern implements is to-day one of the most influential factors in profitable vegetable growing. Many areas are now wholly mechanized, and it is undeniable that such methods are able to bring about a considerable reduction in production costs. For example, the cost of growing brussels sprouts on Suffolk farms under mechanized conditions was found to be approximately one-half the cost in Bedfordshire where horse and land labour were used. In the old days market garden land was either horse-ploughed or dug by hand, and the cost of these single operations would range from £1 to £3 per acre. With modern high-powered tractors land can be ploughed at a cost as low as 10s. 0d. per acre, or even lower.

Tillage covers the operations of ploughing, preparation of the seed-bed and the cultivation of the crop. For vegetables the land should always be ploughed as deeply as the amount of good surface soil present permits. Care should always be taken to avoid bringing raw subsoil to the surface, especially if the ploughing is intended for a seed-bed. If a "pan" or plough "sole" is formed it should be broken up with a subsoil plough. With a good sub-soiling implement it should be possible to break the land to a depth of 18 in.

Tractors. During the present century the steady development of mechanization has been an outstanding feature of all forms of crop husbandry, including vegetable growing. As long as the motor tractor was designed merely to pull the old implements, horse teams continued to hold their own on many farms, for in many instances more accurate work could be done with horses than with the tractor. Gradually, however, implements specially designed for tractor work were developed, and devices

for directly attaching the implements to the tractors made for even more accurate and efficient work. Built-up tool bars with hydraulic lifts have effected a great improvement in tractor tillage. It is now usual to speak of a tractor system, *e.g.* the *Ferguson* System, which implies that tractor, tool bar and implement operate as a single unit. It is probably correct to say that 75 per cent of tillage operations are now performed by tractor units of both wheel and track-laying types.

A more recent development in tractor usage is the power take-off which enables power to be transmitted to the machine being hauled. This feature has enabled a notable advance to be made with spraying outfits and fertilizer and lime-distributing machinery.

The vegetable grower has necessarily to consider tractors in terms of row-crop work, and it is rather unfortunate that the majority of tractors hitherto manufactured in Britain have been designed primarily for general farming purposes. Probably less than 20 per cent of the tractors in use are adaptable for row-crop work, yet in the U.S.A. the position is quite different, and 90 per cent of the tractors used are designed for this type of work.

The essential features of a tractor for row-crop work are adjustable wheels, good ground clearance, and built-up tool-bars with facilities for fitting all kinds of tillage tools. Further, as such types of tractors are required to haul planting machines, several forward speeds. including a slow (crawling) speed, are equally essential. At the same time the tractor should possess sufficient power and weight to plough all classes of soil and to haul heavy loads.

If the tractors available for purchase are examined in the light of these requirements it will be seen that few are entirely satisfactory from the point of view of the vegetable crop grower.

An example of an ideal type of tractor for large-scale row-crop work is seen in the *International* Farmall series, notably A and B, which are manufactured in the U.S.A. These Farmalls are two-furrow tractors. The Farmall A has adjustable front and rear wheel allowing of eight different widths; the Farmall B is a three-wheel tractor with adjustable rear wheels. The parallel tool-bars permit of a wide range of settings of different types of tillage tools. Possessing four forward speeds, three ranging from 1½ to 4¾ miles per hour, with a fourth of 10 miles

per hour for road haulage work, the Farmalls are commendable types of all-round performance tractors for the vegetable grower.

Another notable advance in powered tractor tillage systems is the *Ferguson* System. Incorporating entirely new methods of implement linkage and control, the *Ferguson* System has revolutionised power farming and all large-scale operators are advised to study this system in the light of their individual needs. Another well-known implement system, designed for use with the *Ford* Major tractor, is the Leverington, which was specially designed for row-crop work. The *Case* farm tractor has also a tillage system, incorporating tool-bars specially-designed for row-crop work. Most people connected with the land are familiar with the *Ransome* Toolbar Frame, which is an excellent tool-bar for close hoeing work. A tiller steerage, which gives easy and accurate control, has recently been made available for this tool-bar. The *Allis-Chalmers* and *David Brown* are other useful types of tractors for row-crop work. The *Bean* tractor tool-bar with attachments is a machine of special design suitable for row-crop work.

Many market growers operating small acreages, and those whose holdings are much divided into small area plots for cropping, need efficient small tractors that are capable of performing all tillage operations. Some of these small tractors are of wheel type and others are of the track-laying type. The essential feature of a small tractor is that it should be able to plough average class land without difficulty. As a rule this class of tractor is of the walking type, that is, the operator walks instead of riding as with the larger tractor. Examples of the small tractor that the author has seen doing good work, are the Trusty Tractor made by Messrs. Tractors (London) Ltd., Barnet, Middlesex, and the *Ransome* M.G.2 Tractor, made by Messrs. Ransome, Sims and Jefferies, Ipswich. The former is a wheel tractor and the latter a track-layer. Other general-purpose light tractors that have proved efficient in practice are the Rowtrac (a two-wheel tractor) and the Bristol, a small but powerful tractor of the track-laying type.

Examples of small tillage tractors that work with sets of harrows, discs and hoes, and are adaptable for other purposes, such as seeding and spraying, are the Graveley and the Auto-Culto.

Other necessary implements for the vegetable farm are a cup (coulter) drill, a small hand seed drill, a fertilizer distributor, and hoes, both mechanical and hand.

In connexion with the subject of mechanization the following is the list of implements maintained on a 500-acre farm in Essex completely devoted to the production of vegetables on mechanized lines. Only one horse is kept :—

3 *Fordson* tractors.
3 Tractor ploughs (1 *Cockshut*, 1 *Oliver*, 1 *Ransome*).
1 *Ransome* Y.L. two-furrow plough.
1 Tractor disc cultivator.
1 *Fletch* Tractor Cultivator (adaptable).
1 Tractor fertilizer distributor.
2 Sets of 3 spring tooth harrows.
1 Set of light seed harrows.
1 Horse hoe.
1 *Cambridge* smooth-faced roller.
1 *Smyche* 7-coulter cup drill.
1 Hand seed drill.

A 400-acre farm in Oxfordshire almost entirely devoted to vegetable crops is operated successfully with the following mechanical equipment in addition to 4 horses :—

1 *Ransome* M.G. tractor with *Ransome* cultivator and *Gibbs* tool-bar frame.
1 *Allis Chalmers*, Model B, dual-purpose tractor.
1 *Case* tractor.
1 *Fordson* tractor.
1 *Oliver* Rowcrop model.
1 *International* 10-20 track-laying tractor.
1 *Bean* Rowcrop tractor (also available for power spraying).
1 *Grover* drill for peas.
1 *Baker* brush drill.
1 special radish drill.
2 *Robin* transplanters.

The labour staff of this farm consists of 17 men, 8 women, 4 boys and 3 girls, augmented by casuals as required.

The above lists comprise all the implements required for the tillage work on a unit of from 400 to 600 acres of light loamy land, and serves as an example.

As examples of heavy powered equipment, the author has knowledge of a large farm in West Suffolk mainly devoted to mechanized vegetable production where all the ploughing is done with the *Ransome Junirac* five-furrow ploughs drawn

FIG. 16.—The Italian type of Cauliflower.

VARIETY: "MAJESTIC" (CLUCAS).

FIG. 17.—The Ormskirk Savoy Cabbage.

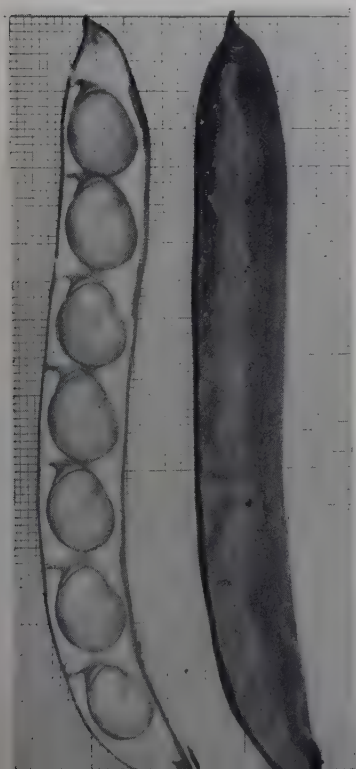
The markets require this green type of Savoy.

FIG. 18.—A field of spring cabbage.

FIG. 19.—Examples of English varieties of peas grown for market. *Left*: Duplex. *Right*: Admiral Beatty.

FIG. 20.—Examples of English varieties of peas grown for market. *Left* : British Lion. *Right* : Gradus.

FIG. 21.—Examples of Longpod type of Broad Bean. *Left* : Seville Longpod. *Right* : Bunyard's Exhibition.



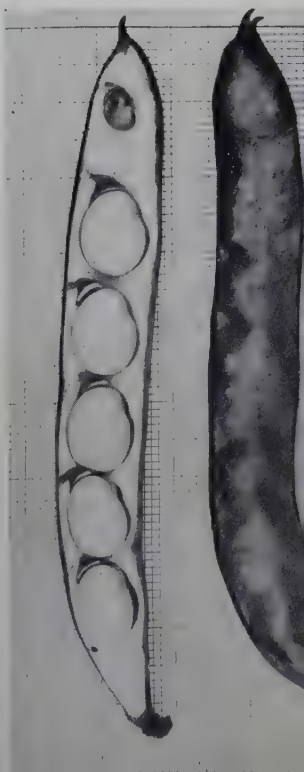


Fig. 22.—A potato planting machine at work. The ridges are opened, planted and closed in one operation.

Photo by courtesy of [illegible]

Fig. 23.—A field of onion-seed.

by Diesel-engined track-laying tractors. With this equipment ploughing up to 12 in. in depth, and subsoiling up to 8½in. in depth, was possible at the rate of from 7 to 8 acres per ordinary working day. Farmers on the heavy loams of the Boulder Clay in Huntingdonshire have to plough and cultivate land for brussels sprouts with the aid of the big Caterpillar Diesel-engined tractors; Figs. 1-4 show various types of tractors and tillage implements. Figs. 6 and 8 illustrate types of hand work.

The Horse as a Source of Power. Despite the extended use of tractors for all types of farm tillage work, the horse can still find a useful place, especially on the smaller types of holdings. They are useful for many jobs for which the tractor is unsuitable. Horses, too, are a source of valuable stable manure for which there is a never-ending demand in market gardening, both as a means of soil improvement and for hot beds, forcing, composting, etc.

A useful type of plough for use with horse teams is the balance or turnover plough (two ploughs in one) which easily deals with small pieces of land where the normal system is a matter of difficulty. With these ploughs no 'lands' are needed and all the furrows are laid up in one direction. The plough is reversed by raising one section and the horses are turned round without unhitching.

The most suitable types of horse for the market grower are the clean-legged breeds, such as the Percheron and Suffolk. It is usually reckoned that horse teams can plough an acre a day comfortably, using two-furrow ploughs. Tractors with similar ploughs can plough at least 3 acres in an eight-hour day. On an average a horse costs about £30 a year to keep.

Ploughing. In recent times the subject of ploughing has come under close examination, and although differences of opinion still prevail some traditional ideas have been abandoned. The value of deep ploughing appears to have been over-rated, and especially when it involves bringing quantities of infertile sub-soil to the surface it is possibly harmful from the point of view of seed-raised crops. Seeds should always be sown in a fertile medium and not in poor sub-soil. The idea that deep ploughing facilitates root development does not seem to be borne out by the facts brought to light by experimental work, and except where "pans" exist such ploughing is not called for.

The art of ploughing is to preserve the valuable fertile top soil, and its real purpose is concerned with the maintenance of surface soil structure, *i.e.* granulation, the burying of weeds, and crop residues and applied manure, and is the first step in the preparation of the seed bed. All heavy types of land should be ploughed in the autumn or early winter so that the weather (frost and wind) can complete the operation of granulation. No amount of tillage can be so effective as "weathering." Lighter soils can be ploughed at any time, provided they are not too wet or too dry (the fundamental principle of all good ploughing is to plough at the right soil moisture condition), and on this type of land the short and steep mould-board, or digger, type of plough performs the best service. These ploughs leave the land level and well broken so that tillage either for planting or seeding is rendered a comparatively easy task. It is best not to plough light land in the sutumn or early winter so as to expose the soil to the washing-out action of rain.

When ploughing-in grass or clover leys, or cover crop grown for green manuring, it is necessary to use ploughs with long sloping mould boards in order to achieve complete inversion of the furrow slice and thorough burial of the surface growth.

Seed-bed Preparation. The orthodox method of seed-bed preparation involves a series of tillage operations usually consisting of discing or scuffling, harrowing, levelling and compacting, but these operations vary according to the type of crop to be grown, size and germinating rate of seed, etc. Compacting, that is, the use of the roller, needs judgment, for while a firm seed-bed is necessary to the effective germination of seed, some soils, especially if heavy rain follows, will quickly form a hard crust, which is an obstacle to seedling emergence. The ideal seed-bed should be firm but with a fairly coarse surface tilth, *i.e.* granulation. A firmly divided and compressed surface soil is not normally desirable. For this reason the roller is often used at an intermediate stage in the tillage operations, the final operation consisting of a light surface harrowing.

The unorthodox method has recourse to the use of a single tillage implement, such as the rotary tiller or rotary hoe, which usually consists of a quickly-revolving drum to which are attached a number of tines or blades that have a pulverizing

effect on several inches of the surface soil. It is clear that this short cut to seed-bed formation involves principles directly opposed to what is considered desirable in ideal soil structure. Rotary tillage certainly provides quickly a satisfactory seed-bed, and one that has been shown to give not only earlier and better germination but improved initial seedling growth. Keen, and other workers at Rothamsted, found this to be true, but they also pointed out that the final crop yields were no better and sometimes clearly inferior to those obtained on land where the seed-bed was prepared in the normal manner by ploughing and tillage. There is, therefore, something to be said both for and against rotary tillage implements and decisions as to their use must be left to individual circumstances.

Crop Cultivation. Views on this subject have undergone substantial modification in recent years. It used to be thought of *vital* importance to maintain a loose layer of soil on the surface as a means of conserving moisture by interfering with capillarity as then understood. Numerous experiments, both in Britain and the United States, however, have shown that there is no evidence to support this practice. More is now known about how water both moves in the soil and is lost to the soil as water vapour. Views as to soil capillarity have been substantially modified, and it is now known that surface cultivation or hoeing can have little effect on this aspect of soil moisture. Indiscriminate soil cultivation may even do more harm than good under some conditions.

Water is lost to the soil by natural drainage, by direct evaporation and by removal by growing plants and weeds (transpiration). It is now known that any marked measure of evaporation no longer obtains at a point when the soil can be effectively cultivated after the application of water by rain or irrigation. Crop cultivations, however, would still be worth their cost if only for the purpose of weed destruction, but there are other reasons why they are useful. First, however, as to weeds.

Weeds not only compete with the crop plants for available soil moisture, but also for available plant nutrients, light and air. They usually come up before the crop plants, and being members of the natural flora have the advantage of enjoying

natural habitat. The crop plants are, therefore, handicapped unless the weeds are controlled. The most effective control is obtained by destruction in the early stages of growth. Hence early and repeated cultivations are necessary unless destruction is secured by the use of herbicides, or flame guns (see later section). The point of importance is that weeds should be destroyed as they emerge from the soil and before they begin to exercise any appreciable drain on the soil's moisture and nutrients. Weeds impede the growth and reduce the weight and quality of the crops. They also retard maturation of the crops.

Cultivations are also concerned with soil aeration. Both the roots of crop plants and the soil micro-organisms require oxygen, and air cannot freely permeate a compacted, crusted surface soil. As the total soil porosity is increased by cultivation the total volume of air in the soil is higher on a well-cultivated soil. Cultivations to improve soil aeration are probably more necessary on flat land than on slopes, as water tends to stand longer on flat land and compact the surface more markedly. Under some conditions, however, oxidation, if excessive, causes a rapid dispersal of organic matter, which is undesirable.

Cultivations are useful from the aspect of the soil's biological activity. There is no doubt that the better aerated the soil the more effective is the decomposition of organic matter and other processes pertaining to fertility.

Lastly, cultivations, by maintaining a good surface tilth, keep the soil below a little cooler and also facilitate the infiltration of water from rain or irrigation. The latter is an important point for the soil is not only more effectively and evenly soaked but, what is often even more important, surface run-off, involving soil erosion, is prevented or reduced to a minimum. Run-off on a hard crusted surface can often be very serious, especially on slopes, and it is also true to say that unless the soil is in a fit condition to receive the water it is not only lost to the crop plants but takes some of the soil away with it. These remarks apply to normal steady precipitation. Storm rains are another matter and often cause serious erosion on uncovered cultivated soils. We are not, however, dealing with the problem of soil erosion in this section.

To sum up, therefore, although our ideas on the subject of

soil cultivation have undergone change, standard practice is much the same, for the following reasons :—

1. The destruction of weeds.
2. The enhancement of soil aeration and biological and chemical activity.
3. The effective infiltration of water from above and prevention of surface run-off.

Why are Crops Cultivated? The reasons for tillage operations to prepare land for a seed-bed for planting are clearly understood. While, however, all raisers of crops are satisfied that crop cultivations do good and are necessary, the reasons for these operations are less clearly understood, perhaps because recent research has shown that cultivations under normal conditions do not have the moisture-conserving effect they were believed to have, and under some conditions may even be harmful.

Apart from the control of weeds, an important point in itself, cultivations have a direct bearing on soil aeration and soil surface condition and structure, and it can be claimed that the loose surface tilth slightly reduces the loss of soil moisture by evaporation. On the other hand, cultivations result in the soil temperature being slightly lower than that of uncultivated land, though this is most apparent on hot sunny days.

Appropriate spring and summer cultivations amongst growing crops allow the maximum amount of air to permeate the soil, and both the micro-organisms of the soil and the roots of growing plants need adequate supplies of air. Thus nitrification is increased at the time when the supply of soil nitrates is most likely to fall short of the demand made by the growing crops.

We may conclude that crop cultivations—apart from weed control—have a special effect on soil structure, air penetration and temperature, all factors affecting crop growth. Weed control is, of course, of primary importance, for as already observed weeds from their earliest stages of growth compete with the crop plants, robbing them of air, water and nutrient elements. Cultivations, therefore, aim not only at destroying weeds but preventing their growth from the seeds resting in the top layers of soil. On the other hand, cultivations by damaging plant roots may easily cause harm to the crops.

Whether cultivations should be deep, medium or shallow, depends on the type of soil. The work should always be done at the correct soil moisture content since the basic motive is to produce a good tilth and the control of weeds. Generally speaking, the poorer the soil structure, *i.e.* granulation, the greater the need for frequent cultivations. Obviously, though unfortunately, the soils that possess a less stable structure are those that require the more frequent cultivations. Conversely, these are the soils that deteriorate most rapidly. The reader will perceive what a special bearing soil structure has upon the subject, and how important is the need to maintain good structural tilth in the seed-bed by growing ley crops, green crops, etc., and ploughing them in at intervals.

Soil Dust Mulch and Moisture Conservation. The view that the frequent loosening of the top few inches of soil by means of cultivations was an important aid to the conservation of moisture in the lower soil and, therefore, beneficial to the crops was formerly generally accepted. Despite the findings of research carried on in England* and in many parts of the world during the past 20 years or so, there are many farmers and growers who still believe this to be true. The belief may be attributable to an imperfect understanding of how moisture moves about in the soil, whether it comes from above as rain or as applied water (irrigation) or from below from static underground water, *i.e.* the water table.

Capillary soil moisture in the top layers does apparently occur in conjunction with the last-named source of water when the water table is within say two or three feet of the surface. This type of soil moisture is termed *real capillary moisture* and can be compared with the movement of the oil in the wick of a lamp. That this upward movement of water could be inhibited by disturbing the capillary tubes was the basis of the theory that in practice a loss of moisture could be prevented by surface tillage and establishing a surface layer of loose soil—the so-called dust mulch. It seldom happens, however, that the natural level of underground water, the water table, is only three feet or less below the surface and so there is seldom any *real capillary moisture* in the top layers of soil.

* John Innes Bulletin No. 1. (3) What is the use of hoeing ?

On the other and, we have to think of the water that enters the soil from above—as rain or as water applied by irrigation—an entirely different matter. When dry soil is rained upon or watered it is found that it becomes moist to varying depths according to the amount of water it receives, but when the water has penetrated the soil it is said to be wetted to its "field water capacity." The manner of movement of this moisture through the soil is a complex physical matter and is concerned first with the liquid and second with the vapour phase of the water. The conductivity in the first, the liquid phase, is concerned with the soil's pore spaces and types of capillary movement.

Closely concerned with this conductivity is, of course, the soil structure itself, and the resistance of the air trapped in the soil pores.

The second, the vapour phase, although of the delayed action type, is significant, for it partly explains why water applied by irrigation or rain "sinks in", as the grower expresses it, so that the amount of soil moistened in the evening, after the evaporation force, the sun, has disappeared, greatly extends itself during the night. After capillary permeability has ceased movement in the vapour phase will continue, being, of course, influenced by temperature differences and other factors. Also, the creation of this hydroscopic soil moisture, involving the movement of water from the top moist layers to the lower and drier subsoil, takes place very slowly.

Thus, as an end result we obtain what is known as the *apparent capillary moisture*, which has been secured largely in the vapour phase. The same can apply, of course, to moisture rising from below by capillary action, the water entering the vapour phase as it nears the surface and comes under the influence of temperature changes, but for reasons already mentioned this seldom happens.

In the same way that moisture *penetrates* the soil in the vapour phase so is it *lost* to the soil in the vapour phase, *i.e.* by being withdrawn by surface evaporation under the influence of solar temperature. The earlier experimenters formed the conclusion that the provision of a loose, dry layer of surface soil by tillage operations would form a mulch which in effect would reduce evaporation. Recent work, however, has shown that on most types of soil almost all of the loss of moisture

through evaporation occurs before the soil is dry enough to permit of tillage work being done to create the dust mulch. As with movement in the liquid phase, vapour movement as evaporation is closely linked with soil structure, *i.e.* particle size and aggregation, while factors such as exposure and soil colour also enter into it.

Thus the reader will perceive that the breaking up of the surface soil by cultivations to form a "dust mulch" can have little "worth while" effect on conserving moisture. In fact, the amount of moisture is so small that the benefit accruing alone cannot pay the cost of the work under English conditions. From other standpoints, however, notably the control of competing weeds, soil aeration and the maintenance of the surface in a moisture-receptive condition, surface tillages are justified.

It will be perceived that the really effective method of conserving soil moisture is to *apply* a protective mulch to the surface in the form of a layer of some material such as straw, hay, paper, grass clippings or manure. The soil beneath the covering, or mulch, is cooler and so loses less water by direct evaporation. In horticultural practice, as many know, mulching the soil is the method that produces appreciable results, and in recent years there has been a development of what is termed "paper mulch culture" for vegetable crops in countries where the preservation of soil moisture is an outstanding problem.

Maintaining Soil Moisture by Irrigation. Because the vegetable grower realises that water is a vital necessity to his crops and that rainfall as a source of water is erratic and unreliable, irrigation, or watering, is now regarded as an essential part of vegetable crop husbandry. The successful operation of holdings depends on an adequate supply of water in the soil for the crops' use. If it does not come from rain regularly enough it has to be put there by other means.

Available water, that is, the water held in the soil, is lost to the soil by the natural intake and transpiration of the crop plants (and any weeds permitted to grow) and by evaporation. Because all the water held in the soil cannot be entirely removed by the crop plants a point is reached when drought conditions operate and the plants begin to wilt although the plants still continue to obtain some water. This point is known as the

soil's *permanent wilting percentage*. The difference between this point and the soil's water-holding capacity (known as the *field capacity* or *capillary capacity*) as measured by the percentage of its weight in water a wetted and drained soil will hold, represents the amount of water the soil can make available to the plant before wilting occurs. Obviously, it will vary considerably according to the type of soil, a sandy or gravelly soil being less effective in this respect than a loam or clay.

The art of skilful irrigation consists of applying just as much water as is required by any particular type of soil to maintain it above the permanent wilting percentage point, not necessarily at its field capacity point.

The furrow or the check system of irrigation is much used abroad. It can be seen being used in France, notably in the market gardens of the upper reaches of the Seine where the river water is conducted to the crops by means of an elaborate system of controlled channels. This system is not, however, used in Britain; instead, the system of overhead irrigation by means of movable spray lines is mostly employed. Other systems make use of sprinklers and rainers of patent design. A recent development in England is the insertion of small quantities of soluble fertilizer in the irrigation water by means of specially designed apparatus.

Cropping the Land. Although holdings devoted to vegetable crop production are usually managed on some recognised system of rotation, such as is commonly practised on arable farms, it will be realised that for several reasons crops of a similar type, with a few exceptions, should not come on to the same land too frequently. Soil acidity is also affected by different cropping and the cumulative effect may be observed in crops susceptible to acid soil conditions.

The vegetable grower, however, has a wider range of crops than the farmer. He is very largely an opportunist, fitting in his cropping as land becomes cleared, this in turn depending on market conditions prevailing at the time. Often the first piece of land available, if in right condition and weather suitable, will be used. Thus the art of successional cropping depends as much on finding crops to keep the land fully used as upon a rigid system of rotation. Nevertheless, it is a good policy to rest a portion of land from vegetable cropping at

least once in three years, when it is either sown with corn or with a temporary ley or clover, now recognised as an excellent soil-conditioning practice.

Cropping has often to be planned to maintain a heavy supply of certain types of vegetables, while others need to be maintained in light supply only. A fairly large holding is required to plan systematically for regular heavy deliveries. Thus the cropping of a 400-acre holding might in any one year be able to show this programme, not taking into consideration any permanent crops such as rhubarb and asparagus:—

Brassicas ...	Spring Cabbage—50 acres. Autumn and winter cabbage—40-50 acres. Savoy cabbage—25 acres. Cauliflowers—10 acres. Broccoli—5 acres.
Legumes ...	Peas—20 acres (sown at intervals from March to May). Beans, Runners 4-5 acres. Beans, Broad 4 acres. Beans, Kidney 4 acres.
Roots ...	Carrots—50 acres (divided between early bunching, maincrops and storage). Turnips—5 acres (half for early bunching and half for storage). Beet—10 acres (5 acres round and 5 acres intermediate types).
Bulbs ...	Onions—10 acres (5 acres for green salad and 5 acres for dry bulbs). Leeks—5 acres.
Salads ...	Lettuce—20-30 acres including over-wintering crop, sown at intervals from March to August. Radish—8-10 acres in several sowings. Cucumbers—2-4 acres.
Miscellaneous	Spinach—25 acres sown for summer, autumn and winter use. Marrows—4 acres.

Some of this cropping can be of the inter-cropping or companion type which, of course, may also be successional in character. Inter-cropping as an art, however, is mainly practised in market gardens of the intensive type, as it calls for more hand labour and offers less facility for the use of machinery.

One example of *successional* cropping is early lettuce followed by beans, followed by winter turnips or spinach. Another is early carrots followed by beans, followed by cabbage. The

examples of inter-cropping, based on the principle of planting small, quick-maturing crops in company with large, late-maturing crops, are radish and lettuce with cabbage or celery, early summer cabbage and tomatoes, early potatoes and cucumbers or gherkins. In general crops, such as lettuce, endive, carrots (early), spinach, tomatoes, dwarf beans, cucumbers and gherkins are good for inter-cropping with late and larger crops, for the last four are climatically controlled and usually disappear with the first keen frost. Inter-cropping can also be practised with freshly-planted long-term permanent crops, such as asparagus and rhubarb, provided care is taken to ensure that the latter are not impoverished by being deprived of nutrients. The main idea of inter-cropping is the utilization of unwanted space and surplus nutrients—important points where land charges are an expensive item in production costs.

Weed Killers or Herbicides. The first weed killers were chemical substances applied in solution, which had a burning or corroding effect on the plants. They were positive in action, *i.e.* non-selective, and were (and are still) used mainly on paths, drives, courtyards, railways, where any form of vegetation is out of place. Mainly of a proprietary character (although diluted carbolic acid was also used), the basis of these weed killers was usually sodium chlorate, sodium arsenite or allied compounds of arsenic ; and being of a highly poisonous and dangerous character their use called for responsible supervision.

The first *selective* weed killers were apparently of the "lawn sand" type. Lawn sands usually consisted of ammonium sulphate mixed with dry sand or brick dust, and they either killed or checked the growth of certain weeds in lawns without seriously injuring the grass. The use of selective herbicides also extended to arable crops when farmers began to use solutions of sulphate of copper and sulphate of iron for the destruction of charlock, wild radish and other weeds in corn crops. The solutions, which were absorbed by the leaf, stem surfaces and buds of the weeds, had a poisoning effect. The fact that growing points of the cereal plants were protected by the surrounding leaf sheath and that the small adhesive surface offered by the narrow leaf blades did not "hold" the solution, enabled the crop plants to escape serious damage.

The amounts used to secure an effective control of weeds

were from 40 to 50 gallons of copper sulphate solution, of a 2, 3 or 4 per cent concentration, per acre, and a similar amount of iron sulphate solution of a 15 per cent concentration. The solutions were sprayed on the crop. Not all weeds were killed and some were only injured.

In recent times the discovery that a sulphuric acid solution also possessed a selective and more generally efficient action has led to its widespread adoption as a herbicide for cereal crops on the farm. It was also discovered that sulphuric acid was an effective herbicide for controlling weeds in onions when used both as a pre- and a post-emergence spray. The spraying of onions to control weeds is now standard practice, and sulphuric acid is probably the most effective material to use, despite the fact that because of its corroding effect on clothes and sprayers it is not easy to use. Almost all the usual weeds, except grass and thistles and docks (which are severely scorched) are destroyed, while the onion crop, although it may be slightly damaged, is seldom injured to any serious extent.

Effective selective herbicides of a proprietary character for controlling weeds in cereal crops are also now marketed. Some of these are composed of copper chloride, while others are dinitro-ortho-cresol compounds, usually referred to as BNOC. Others, which represent a new departure, are a development of much interest. They arose out of the original observation that types of growth-promoting substances (of an auxin or hormone character), which have been named 2-methyl-4 chloro-phenoxy-acetic acid, and and 2:4 di-chloro-phenoxy-acetic acid and called for short MCPA and DCPA respectively, have a powerful effect on the opposite sense when applied in excessive concentrations. They thus act as plant poisons, acting through the root, and not through the leaves. These substances have been developed commercially, and are being marketed both as sprays and dusts under various proprietary names, *e.g.* Agroxone and Phenoxyl, and although possessing no value for controlling weeds in horticultural crops, such as onions and leeks, they have been found to destroy certain weeds in corn crops to a satisfactory extent. Weeds so destroyed include yellow and white charlock, corn buttercup, sherpherd's needle, and penny cress, while corn poppy, fat hen and goosefoot are sufficiently destroyed or injured to check growth. Perennial

weeds, such as docks and thistles are often partially suppressed by these herbicides.

It must be stressed that the effective use of selective herbicides depends on their being used in the early stages of weed growth, that is, in the cotyledon and first rough-leaf stages. This is especially important in the case of sulphuric acid. That is why their use is recommended both as pre-crop-emergence and post-crop-emergence sprays. It should be emphasised that sulphuric acid is the only safe selective herbicide for use on certain horticultural crops, onions and leeks, and that no substance has yet been found for treating crops of roots and brassicas with the exception of carrots for which T.V.O. is now being used.

Weed Burners. The destruction of weed seedlings by the use of controlled fire has now passed the experimental stage and taken its place in standard practice. The fundamental principle governing the use of weed burners is the quick destruction of seedling plants of annual weeds while they are young and tender, and, of course, before the sown crop plants have emerged.

Weed burning equipment of modern design is in no sense a flame thrower, such as is often used to destroy plants and bushes of large size. The flame is similar in type to, but much larger and hotter than, the painter's blow-lamp. It is clean and not raw and oily.

The apparatus is carried knapsack fashion by the operator who holds the head of the burner an inch or two from ground level so burning off all weeds in a 6-9 inch strip as he goes along the rows at a slow speed of about 1½ miles per hour.

One advantage of the weed burner is that it can be used with good effect when the soil is too wet for hoeing, so preventing the weeds from obtaining a good start. A good type of weed burner should therefore be included in the general equipment of all holdings. Crops on which weed burners can successfully be used include onion, cabbage, beet, carrot, parsnip, turnip and lettuce. With all these good weed control is securable without harm to the crop plants or damage to the soil. It is only the weeds that are coming through the soil that are destroyed, the weed seeds and those just germinating beneath the surface not being affected.

CHAPTER FOUR

The Crop Plant

The use of reliable seed is a point of very great importance in the production of vegetables for market; indeed, there is good reason for regarding it as the point of supreme importance. The experienced grower always pays very great attention to the question of seed, and the many good seedsmen who now serve the vegetable growing industry are, fortunately, continually striving to maintain and improve their stocks of standard varieties and strains thus rendering efficient service to the industry. The grower in turn should protect his interests by refusing to buy cheap, unreliable seed obtained from unknown sources.

The factors of importance concerning seed are strain, vitality, purity and freedom from disease. The grower who fully understands the importance of these factors possesses a considerable advantage in the running of his business.

Seed Production. Although normally much of the vegetable seed used in Great Britain is imported, being obtained from reliable seed growing houses as far away as New Zealand and California, and as near home as Italy, France and Holland, it has been demonstrated that seed of nearly all our market vegetables can be successfully grown at home. An exception of note is the autumn (Italian type) cauliflower, most of the seed of which comes from Italy and Spain. Lettuce is also a difficult crop to seed in Britain but crops have been secured in recent years.

Vegetable seed growing is actually an important industry in parts of England, the chief centres lying in the Eastern half of the country, particularly in the counties of Essex, Suffolk,

Norfolk and Cambridgeshire, where the climate is more favourable. It is true that on occasion the weather conditions of late summer and early autumn may be unsuitable for the successful harvesting of seed crops, and the quality of some classes of seed, such as peas. beans, onions, may be lowered in consequence. Naturally all seed crops require bright, dry weather conditions during the ripening and harvesting period, and the English climate is not fully reliable in this respect; but we can generally grow in England seed that compares favourably with any that is imported, and many vegetable growers make a practice of saving seed of their own selected strains of such crops as cabbage, brussels sprouts, onion and celery, the idea behind this practice being that there is a good deal to be said for a strain specially adapted to a particular soil and climate. For the benefit of those who would like to save seed, a brief note on the subject of seed growing has been provided at the conclusion of each section dealing with the various vegetables in the following chapters.

Mendelism and the Grower. Every vegetable grower owes a debt to Mendel, who first discovered the laws of inheritance concerned with breeding and termed Mendelism. Mendel studied carefully the inheritance of various characters in the culinary pea by crossing round-seeded with wrinkled seeded, green-podded with yellow-podded, talls with dwarfs, and so on. He discovered that there were hereditary factors that are inherited as a whole and not in varying degree. These he termed "dominant" and "recessive" according to their appearance in each generation. He then formed the theory that in the breeding cells or gametes there are sets of determinants or factors corresponding to each inheritable character, and that each individual, whether plant or animal, possessed a double set of these factors. The character of an offspring, postulated Mendel, depends on whether it has none, one or two sets of factors. Mendel's work (it was revealed to the world in 1886), attracted little or no attention at the time, but the basic laws enunciated in his findings were rediscovered and confirmed by later workers, including Bateson, in 1899, who acknowledged the prior discovery.

From then onwards Mendelism took its place in the science of plant and animal breeding. The basic theory was developed

until it had become abundantly clear that the hereditary factors (now termed genes) were localised portions of the chromosomes of the cells, and it followed that inheritance and the production of variations was directly concerned with the chromosome mechanism. This mechanism operates in the production of the reproductive cells by effecting a *reduction* in the number of chromosomes to half by simple division. The full number is restored in the egg cell after fertilization by adding the chromosomes of the male cell and it is then, of course, that changes in the gene constitution of the zygote may take place and give rise to new forms or individuals unlike the parents.

It has also been made clear that changes in the chromosome arrangement do occur without any known cause, such aberrations giving rise in the individual to variations that may be great or small, advantageous or otherwise. Such changes may occur both in the somatic or body cells of the plant (all are familiar with the bud sport) or in the germ cells. Amongst our crop plants the pea is notable for the facility with which it produces mutants, or offtype plants. Such changes or mutations of the germ plasm occur by the operation of unknown causes, but are definitely inheritable and may be carried by individuals that do not display the characters they are transmitting. Some light, however, has recently been thrown on the matter, for such changes have experimentally been effected by X-ray treatment of animals and colchicine treatment of plants. It is quite clear that alterations in the chromosomes so effected produce variations that breed true.

Breeding. There is evidence that from the dawn of history man devoted much attention to the task of improving crop plants, and the vegetables were included. The wild prototypes of many, such as the cabbage, carrot, parsnip and kidney bean, may still be found, while others have been lost in antiquity. Selection, as opposed to scientific methods of plant breeding, was, of course, the chief method employed in the evolution of many of our present-day types of vegetables. Selection, however, does not create, but merely takes advantage of what is inherent in the plant itself, in other words it exploits the tendency to produce variations.

The fact that the selection method of crop improvement

can still be practised with advantage indicates that the existing strains, or so-called varieties, are often an impure stock, and are, in many instances, simply a mixed population with one or more features in common. This does not mean that selection has not played an effective part in the development and maintenance of types; undoubtedly it has served the industry very well up to a point. The reader has only to cast his mind over the wide range of excellent types of vegetables to realize this. They are mostly the result of the selector's art.

Before leaving this important matter, the general question of what constitutes a variety, and how varieties are originated, should be examined. The following extract from a botanical journal is quoted because the author feels that it is the clearest account of the subject he had encountered:—

"The observant botanist who travels from country to country or even from district to district, cannot fail to be struck by the infinite variety of vegetation and by the fact that its very diversity depends largely on its surroundings. In Alpine regions stunted, bright-flowered plants prevail, and often their leaves are hairy; deserts, too, are rich in dwarf vegetation, and spiny and succulent leaves abound. In short, the desert, the mountain, the forest, the bog and saltmarsh all possess a characteristic vegetation, which is typical of similar districts the world over. The soil, climate and altitude all have a definite effect on the vegetation, and tend to create *varieties*. These varieties arise as a result of any attempt on the part of the plants to counteract the deleterious effects of their surroundings.

"Plants transported, either by accident or design, from surroundings of one kind to surroundings of a totally different nature, say from a moist climate to a desert, will die unless they have the power of adapting themselves to the new conditions, but it is fortunate that plants as a whole possess this adaptability to a marked degree. In the case of cultivated plants, there is not so great a need for adaptability, the husbandman, if he knows his work supplying the deficiencies of nature. All this is well known, even to those blessed with limited powers of observation. What is *not* so well known is that individuals of the same species vary. Each one, so to speak, has its own facial expression, each one shows certain

characteristics different from its neighbour. When a row of young trees are planted side by side in a nursery each tree does not grow in exactly the same manner as its neighbout, be the husbandman ever so careful to raise them under similar conditions. Some trees will shoot up far above their fellows, some will branch freely, others but little; large and small-leaved trees will arise. Each tree will exhibit some variation; it may be exceedingly slight, but there it will be, and it is simply an adaptation to enable the individual to succeed in the struggle for existence.

The supply of food, water and light, together with temperature, altitude, maritime growth, and climate, singly or several together, all tend to produce variations in plants. Concerning the importance of food supply in bringing about variation, Darwin says: 'Of all causes which induce variability, excess of food whether or not changed in Nature, is probably the most powerful.' Because food supply exercises such a powerful influence on vegetation, we cultivate and manure the soil, and when a true stock of seed is required we raise it on poor, unmanured land. Excessive food produces an increase in size; at the first the increase is general in all the organs of the plant, but continued rich cultivation may later lead to increase in one or more organs relatively to the others. Variations in shape, colour, texture, etc., are a frequent aftermath of the original increase of size. Lack of food conversely produces a *reduction* in size, and, as a consequence, a general weakening. The physical character of the soil, quite apart from the effects of food and water, has a considerable influence on variation. Pliny is said to have recorded the same effect as known and utilized in Greece in his time."

From the foregoing the reader will gather how important it is to select the correct conditions of soil and climate for the growing of seed crops of vegetable plants. Climate, particularly, is a factor known to be of some practical importance in maintaining vigour of stock and high viability in the seed.

Varieties of Vegetables. The term "variety", so long applied to the many variations in form of our cultivated crop plants, whether propagated vegetatively or by seed, is now used,

and has been used, in so many senses that much as it has served every-day practice it might well be dropped. Certainly the term "variety" when applied to vegetatively-propagated plants stands for something altogether different from what is implied when it is applied to seed-propagated plants. A vegetatively-propagated plant is usually an original seedling going back maybe 100 years, though sometimes it may be a selected form of a species, in which case the term "variety" is more precisely applicable. Only the somatic cells of the original meristematic tissue are concerned in propagation, and the one plant variety so perpetuated is really a "clone",* a better term for it. On the other hand, all crops propagated by seed are involved in each generation with the complex chromosome mechanism of the gametic cells (ovules and pollen grains), hence, under the usual conditions of cross-pollination, it is impossible for a seedling to be absolutely identical with the plant from which the seed came. It is true that with many of our field and vegetable crops prolonged and consistent selection for uniformity has resulted in genetic cells of both pollen grains and ovule carrying characters much alike and resembling those of the parent plants. This is what selection has accomplished with many of the crops dealt with in this book, with the result that a sufficient proportion of plants in each generation resemble the desired type to be satisfactory for all practical purposes. Nevertheless, this type of so-called variety tends to resemble a mixed population, and this fact is often clearly apparent in instances where there is an absence of genetical stability.

We have to face the fact that just as strains and new forms are known to arise even in clonal varieties by bud variation or mutation (cytological aberration), so variations will (and more frequently and naturally in view of the mechanism involved) constantly arise in seed-propagated plants. When more or less uniform seedlings are produced the geneticist speaks of their parents as being homozygous.* Parent plants that give rise to seedlings that differ not only from the parents

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* Clone—A succession of generations of a plant formed by vegatative reproduction, i.e., without a sexual process, and derived from a single ancestor.

* Homozygous—Carrying in the body (somatic) cells *one* kind of a pair of alleles.

but amongst themselves are termed heterozygous.* Fortunately, careful selection continued for many years does in many instances confer a condition approaching the former.

Oddly enough, while reliable seed of many of our crop plants is secured by saving seed from a stand of plants carefully isolated and grown in such a way as to ensure that contamination by pollen of another type form or variety does not occur, with at least one crop, sweet corn, seed growers deliberately plan to obtain single cross hybrid seed. Intermingled rows of two special lines are grown in the same plot and the male tassels of the line not desired as a pollinator are removed. A somewhat complex system of crossing is employed with other parents, under which the resultant hybrids are referred to as *top cross*, *three-way cross* and *double cross*, but the main objective is to secure the extra vigour, yield and uniformity inherent in hybrid seed, this more than paying for its higher cost. Such seed, of course, is only used for the one generation crop, as, coming from parents of diverse type, it would lack uniformity in the next generation. In short, the hybrid sweet corn seed is heterozygous and useless for seed purposes, much as it gives a advantage in the first planting.

The multiplicity of varieties or forms, or, it may be more correct to say, *names*, embracing the cultivated vegetables is somewhat bewildering, even to the experienced grower. Many of them are only selections from some well-known strain; others, it is regrettable to admit, are just fresh names for old varieties or varieties imported from abroad under a different name. A catalogue issued during peace-time, before the late war, by one of the leading firms of seedsmen in England catering for the commercial grower, listed 115 varieties of peas, 62 varieties of the three different beans, 32 varieties of beet, 50 varieties of cauliflower and broccoli, 75 varieties of cabbage and savoys, 27 varieties of carrot, 55 varieties of lettuce, 48 varieties of onion, 33 varieties of tomato, and 30 varieties of turnip.

During the late war period, in 1942, a most useful step was taken by the Ministry of Agriculture for England and Wales, when, after deciding that a reduction in the number of varieties listed by seed merchants was desirable, the Department asked

* Heterozygous—Carrying in the body (somatic) cells *each* of a pair of alleles.

the Seed Production Committee, established in 1942 under the control of the National Institute of Agricultural Botany, to consider the possibility of preparing a standard list of varieties. This action was designed as much for the elimination of unnecessary varieties, forms and synonyms as to secure the production of a full range of vegetable seed with the minimum amount of complication in the placing of contracts. Although a war-time measure this action served an extremely useful purpose in assisting to clarify the general picture for the grower as much as for the seedsman. This list of standard varieties of vegetables approved and recommended by the Seed Production Committee is given in Appendix V, and should be studied by all who are interested in this important subject of varieties in vegetable plants.

In recent times, however, the improvement of crop plants has been developed on more scientific lines, and at all modern plant breeding institutions this work is conducted according to the known laws of heredity, laws first enunciated by Mendel, and first applied to breeding by such men as de Vries, Bateson and Johannsen. Making use of these principles the scientific plant breeder not only produces absolutely new and valuable varieties that possess superior market qualities, and superior yielding capacities compared with older sorts, but is able to develop such valuable, and often vital, qualities as resistance to disease and insect attack. Types of plants produced by scientific methods of in-breeding are often termed "pure lines" a term, however, of a rather loose character and one which must be regarded with some reserve. Admittedly a new type of vegetable plant may be a "pure line" as far as it is humanly possible to free it from genetical impurity, and if of a self-fertilized type it can be relied on to produce offspring resembling its parent and possessing desired qualities of a more or less fixed character. The term "pure line", however, loses some of its significance when it is considered that many of our vegetables cross-fertilize very freely and that many plants tend to produce variants, even when they are self-fertilized "pure lines", because of inherent genetical instability.

Examples of normally self-fertilized vegetable crop plants are peas, beans, lettuce, tomatoes, while leading examples of those that normally cross-fertilize are cabbage, brussels sprouts, cauliflowers, broccoli, turnips, beet, carrots, parsnips,

onions, vegetable marrows, cucumbers. It follows, therefore, that unless very great care is taken in seed production, there is always a risk of the carefully bred and desirable types being crossed with either undesirable cultivated types or even wild forms. This naturally leads to deterioration of the stock. When growing seed, therefore, the stocks should always be carefully isolated, and not only should all other seeding varieties of the same crop be eradicated for a considerable distance around the seed crop, but even related members of the family should receive similar treatment. This rule applies with particular emphasis to the Brassica group, most members of which can freely intercross. Many growers are familiar with the strange plants resembling kale in their crops of brussels sprouts. These are usually the result of cross-pollination in the seed crop.

The following methods are principally employed to-day in connexion with the improvement of vegetables and the maintenance of good stocks of existing types.

(1) *Single-plant Selections.* Promising individuals of self-fertilized plants are selected and carefully isolated for seed. The stock thus obtained is grown on in isolation and re-selected over several seasons before being sent out. Many good forms are obtained in this way. Peas, beans, cabbage and roots are improved in this way.

(2) *Mass Selection.* A *number* of promising individuals of either self-fertilized or cross-fertilized plants are selected and grown on together for seed. This is a favourite method with Brassicas that are either partly or wholly self-sterile, and is, of course, essential with crops that are dioecious, that is, bearing the male and female flowers on separate plants, such as asparagus and spinach. This is a method usually employed by the commercial seed grower.

(3) *Controlled Hybridization.* Desirable forms of both self- and cross-fertilized plants, which have been grown under careful observation, are crossed with the object of obtaining types that combine the good qualities of both parents. Where practicable individual flowers are so crossed. This practice makes use of scientific breeding principles in the case of crossing inbred homozygous forms, the hybrids obtained from these

controlled crosses being subject to Mendelian laws of segregation. By breeding on to the F_3 generation new fixed types may be secured. It is work of a long-range character calling for careful study of the subject under improvement and a painstaking system of recording.

The fact that most of our commercial types of vegetables were obtained, and are maintained, by selection, and are therefore genetically unstable, means that seedsmen must be constantly re-selecting their stocks in order to maintain the character of the original types. By making use of "one plant" selection method certain definite improvements are often secured, and there is then a temptation to give the stock thus obtained a new name. Actually this new stock is merely an "improved" strain of the original type. This practice, unfortunately, has led to the position in which we are faced with the fact that there are considerably more names than distinct varieties of vegetables. Nevertheless, it will be clear to the reader that the question of "strain" is a very important one, and growers seeking seed of the well-known varieties of vegetables cannot afford to neglect to obtain good "strains". Seed of a good re-selected and carefully rogued stock is usually higher in price than common stocks. Cheap seed is therefore very often dear in the long run for more reasons than one.

Finally, it is hoped that when the great majority of vegetable growers become more aware of the advantages of improved plant breeding methods, and are better informed as to the nature of much of the material they have to use to-day, the old systems of seed production will give place to more scientific methods. In this way yields per acre will be raised, market qualities will be improved, and cash profits will be increased.

In this country plant breeding in connexion with vegetables is carried on at the Cambridge Horticultural Research Station and the John Innes Horticultural Institution, Merton, Surrey, where much valuable work has already been carried out, particularly in relation to onions, cauliflowers, broccoli brussels sprouts and sweet corn. Improved types of these crop plants are made available to market growers through the normal trade channels.

Germination (Vitality) and Purity. Seed possessing a high rate of germination is essential to economic crop production. Without some knowledge of the germinating capacity of the

seed, the vegetable grower cannot estimate the amount to be used, and even if the seed is "home grown", either a home germination test should be made before it is used, or a sample sent to the Official Seed Testing Station at Cambridge. It is impossible to tell from an inspection whether seed is good, bad or indifferent. As the purchaser of seed is protected by the Seed Regulations made under the Seeds Act of 1920, it can be safely said that the grower is no longer exposed to the risk of wasting time, money, good land and manure on seed that will not grow. The percentage of germination must, in accordance with the Regulations, be declared by the seller at the time of sale.

Similarly, the grower no longer runs the risk of sowing pernicious weed seeds along with the seed of the crop, as the Regulations referred to above require that the percentage of purity, in the case of vegetable seeds, must be stated if it be less than 97 per cent (90 per cent in the case of carrot). Not only weed seeds, but rubbish, broken and damaged seeds are either classed as impurities or stated as such on the test report form.

Germination Energy. This seed factor has come to be regarded as an important aspect of crop production. A condition of low vitality in seeds is often caused through a bad harvest, improper storage conditions, insect or disease damage, or the deterioration of age. The germination energy may be so low as to affect the vitality of the seedlings under open ground conditions. Fortunately, there is some degree of correlation between germination energy and the actual percentage of germination. It is held that seed giving a very low rate of germination may be from either old or badly harvested stocks.

Longevity in Vegetable Seeds. The longevity, or length of time seeds retain their vitality, is a matter of some interest to all crop raisers. While it is very difficult to generalise, so much depending on such factors as temperature and humidity of the seed store, the original harvested quality of the seed itself, and the kind of seed, it can be stated that given appropriate storage conditions the seeds of many vegetables retain their vitality for from one to five years according to their kind. Humidity is

definitely the enemy of all stored seeds, and does more harm that a moderate rise in temperature can accomplish where the humidity is reasonably low. The atmosphere of a seed store should, therefore, be both cool and well ventilated, and above all, dry. Some favour keeping the seeds in air-tight containers, but they can be kept quite satisfactorily in linen or cotton bags under the conditions indicated. It is, moreover, risky to seal up seeds unless one is certain that they are thoroughly dry. Most authorities agree that the seeds of parsnip and onion retain their vitality much less satisfactorily than other vegetables and it is not advisable to use seed more than a year old.

The following table of longevity is sufficiently reliable for all practical purposes.

Kind.	*Years.*	*Kind.*	*Years.*
Asparagus	3	Onion	1
Beans	3	Parsley	2
Beet	4	Parsnip	1
Brussels Sprout ...	5	Pea	3
Cabbage	5	Pumpkin	4
Carrot	3	Radish	5
Cauliflower	5	Salsify	2
Celery	6	Spinach	5
Chicory	3	Sweet Corn ...	1
Cucumber	5	Tomato	4
Endive	2	Turnip	5
Kale	5	Vegetable Marrow ...	5
Lettuce	5		

Seed-borne Diseases. Vegetable growers often do not fully realize the significance of the term "seed-borne disease". It is very important to appreciate the fact that it is possible to sow with the seed a disease that will ultimately rise up and destroy the crop raised from it, and all the good land, good manures, and time and money spent on cultivation will be lost. Pedigree seed, unless it is also disease free, will be of no avail. There is no doubt that some diseases of food crops have traversed the whole globe by means of the seed, and in such manner are introduced from one country to another.

The following are examples of diseases of vegetable crops definitely known to be seed-borne :—

ONION SMUT (*Urocystis cepulae*). This disease is now fairly prevalent. It destroys the Seedlings. Seed is infected, but the disease also arises from spores in the soil.

CELERY LEAF-SPOT OR BLIGHT (*Septoria* spp.). This disease often widely prevalent and destructive, is clearly and definitely seed-borne, and as much as 50 per cent of some stocks have been found to be infected. A substantial proportion of the new outbreaks of this serious disease of celery must be due to the sowing of infected seed. The fruiting bodies of the fungus are attached to the seed, and may be seen with a good lens as minute black dots. Steeping the seed in a solution of formalin, 1 part to 300 of water, will destroy a high percentage of the spores in these bodies. As a safeguard, no celery seed should be sown unless it has been so treated beforehand or is guaranteed to be 'clean.'

BEETROOT DRY ROT (*Phoma Betae*). This diseases is definitely transmitted by infected seed and the fungus concerned may attack seedlings causing the trouble known as Black Leg. Treatment with an organo-mercury dust will give a control on infected seed.

BEETROOT RUST (*Uromyces Betae*). This diseases of beetroot, mangolds and sugar beet may be carried by the seed by means of teleutospores which bring about an attack on the resulting crop.

BLACK LEG OF MANGOLDS AND BEETS (*Phoma Betae*) which causes the seedlings of these crops to blacken off and wither up, resulting in disappointment and loss to the grower, is also seed-borne.

PARSLEY LEAF SPOT (*Septoria Petroselini*). This disease is carried by the seed in the same way as Celery Leaf Spot. Seed treatment of a similar nature is advised.

PEA LEAF AND POD SPOT (*Ascochyta* spp.) is a disease that takes the form of fairly large, irregular, pale spots, surrounded by dark lines, on the leaves, stems and pods of peas ; it is fairly common and reduces the health of the crop. The pea seeds also become infected, and when harvested for seed the diseases persists in them and is carried over from one season to another, so causing losses of seedling plants which become infected from the seed. If the presence of this diseases is suspected, it can be confirmed by keeping a sample under moist conditions for a short period. Spores will then appear on the dark spots, and their nature may be determined by means of a microscope. The remedy is to treat the seed before sowing with one of the organo-mercurials.

TOMATO STEM AND FRUIT ROT (*Didymella Lycopersici*) is now known to be carried over by seed, though it is mainly from discarded diseased material that fresh infection arises each year.

CANKER OF BRASSICA CROPS. *Phoma lingam*. Seed is sometimes infected and is effectively treated by immersion in hot water (temp. 122° F.) for 20-25 minutes.

PLANT VIRUSES. It is known that certain of the plant viruses, such as Mosaic in Kidney beans, are carried in the seed from one generation to another.

Insect and Animal Pests. Not only are diseases carried about in the seed of various economic crops, but insect and other pests also. The farmer is familiar with "cockled" wheat, caused by an eelworm that passes from the plant to the seed and subsequently back again. Seed analysts are aware of the damage caused by Foxtail Midge and Cocksfoot Moth in grass seed.

Vegetable growers are exposed to the depredations of Bean and Pea Beetles (*Bruchus* spp.), and the Turnip Weevil (*Ceutorrhyncus assimilis*), which infest the plants and often the seed of these crops.

Enough has been said to indicate the important part played by all the points enumerated at the outset of this Chapter. What can the grower do ? First let him appreciate the fact that "cheap" seed is commonly dear seed. The seed merchant who endeavours to supply seed that will not only grow, but grow vigorously, that is of good *strain*, is true to type and will carry with it no destructive disease or pest, has to charge a fair price for his product. Many successful growers always obtain the best seed that money can buy, because a good price paid for seed resembles an insurance, and in the long run the cost of seed is a small item compared with the costs of land, cultivations and manures, all of which may be utterly wasted by the injudicious purchasing of seed.

Mention should also be made of the provision that exists to enable farmers and market gardeners to have tested for their own satisfaction seeds which they have either purchased or grown themselves. Samples of seeds may be forwarded to The Chief Officer, Official Seed Testing Station, Huntingdon Road, Cambridge, for a report as to germination and purity, the charges for which are nominal. With regard to seed-borne diseases, samples of peas and celery may be examined for the presence of diseases, but as this examination is of a specialized character, a fee of 2/- per sample is charged.

The Disinfection of Seed. The treatment of seed suspected to be infected with one or other of the seed-borne diseases is now a common practice. Chemicals, such as formaldin and organomercury compounds are used for this purpose. The use of the latter on cereal and sugar beet seed has now become standard practice. Many pea growers similarly dress their seed with

mercurial compounds as a precuation. Formaldehyde as formalin, principally used for dressing celery seed, is procurable in the ordinary way from chemists, but organo-mercurials are marketed as proprietary preparations, and are sold under such names as "Ceresan" (Bayer Products Ltd.), and "Agrosan G.N." (Plant Protection Ltd.)

The Sale of Seeds. The Corn Sales Act provides that seeds as well as corn must be bought and sold by weight and not by measure. The weights given below are for a bushel measure (approx.) of the kind of seed stated :—

Beans, Runners	50 lbs.
„ Kidney	60 „
„ Longpod Broad ..	54 „
„ Windsor Broad ..	50 „
Cress	56 „
Mustard	56 „
Peas, Round	60 „
„ Wrinkled	56 „
Radish	56 „
Spinach, Round ..	40 „
„ Prickly ..	32 „
Turnip	52 „

Seed Sowing—the Use of Seed Drills. Although a few crops, such as radish and turnip, may be sown broadcast, most vegetable crops are row crops and much depends both on the even spacing of drill rows and the even sowing of the seed in the drills. This is where the grower resorts to machine sowers or seed drills of which there are several types suitable for vegetable crops, ranging from the ordinary farmer's grain drill to the small types of hand drills.

The ordinary cup grain drill can be used for sowing several crops provided it is suitably adjusted to give the appropriate delivery rate and either some feed spouts are stopped up, or the coulters removed, to give the desired row width. For example, the 12-coulter *Suffolk* grain drill normally seeding at 7½ in. spacing, can be arranged to sow at 15 in., 22½ in. and 30 in. row widths by just removing the unwanted coulters. If row widths other than these are desired, then the coulters must be moved. Some types of grain drills have bean-planting attach-

ments that can be used to sow the larger types of kidney beans and runner beans. The grain drill can also be successfully used to sow root crops, such as carrots, turnips, swedes and beet, and bulb crops, such as onions. Mixing small seeds with fine dried earth, sand or wood ashes assists even distribution and is worth adopting. When adjusted to sow at wider row widths than the normal spacing of the drill the implement should be fitted with a marker to enable the operator to get the drill wheel correctly placed when returning. For 30 in. drilling, however, the drill wheel can follow its own outer wheel mark instead of the last drill mark as when sowing grain.

There are a few makes of small 3- or 4-row drills especially designed for sowing small seeds, to be drawn by horse or tractor power.

There are several makes of small hand-drills, most of which sow one row or two rows at a time. They are quite satisfactory when used properly and are useful for brassica seed-beds, lettuce, small areas of roots, beans and peas. They are fitted with markers, to obtain accurate row spacing, and press wheels to obtain a uniform depth of soil covering and an even plant.

Some growers prefer to space out the land before drilling, using adjustable markers that make shallow marks over which hand-drills are guided. Units up to 5 acres may be efficiently seeded in this way.

When fertilizers are applied before sowing the seed they should, as a rule, be mixed completely with the soil by cultivations or raking so that no appreciable amount comes into contact with the germinating seed and so cause injury through burning. Light dressings of phosphatic fertilizer, preferably in granular form—though superphosphate may be used—may, however, be drilled with some types of seed without harm, and often with considerable advantage to the crop. For this purpose the combine drill was devised and has proved a valuable implement in practice for cereal and root crops. It is not wise to use the combine drill for peas and beans and certain other crops possessing sensitive seed or seedlings.

Hand-Sowing. Very little sowing by hand is normally done on commercial holdings, but occasionally it becomes necessary to use this method. Shallow drills are drawn against a line with a draw hoe or a special drill tool. The seed is shaken into the

drills from a tin so shaped as to deliver appropriately, or from a stout sealed envelope with a small opening, using a back and forth movement. This gives a better distribution than sowing with finger and thumb. The drills are then covered by "kicking" in the soil or by using the back of a rake. It is a good plan to tread or roll the soil after hand-sowing and rake over the surface lightly, as all seeds germinate better in firm soil, which holds moisture better than when loose.

When seed is sown broadcast the soil must possess a particularly good tilth and be rather on the dry side. The seed is shaken out of a container or hand distributed (the latter requires more skill) and is then raked or harrowed in.

Plant Raising and Transplanting. The *Brassica* crops are usually transplanted crops. Other crops transplanted are celery, lettuce, tomatoes, leeks and onions. Thus the arts of raising plants and transplanting are an important aspect of vegetable growing. Much, however, depends on the quality of the plants transplanted and that in turn depends on the method used for raising the plants.

The Importance of the Seed-bed. As good plants cannot be grown in poor soil, both the physical and nutrient condition of the seed-bed should be satisfactory. The land to be used as a seed-bed for *Brassica* crops should be well ploughed and manured in the autumn, laying up the soil as roughly as possible. Newly-broken ley land should not be chosen for seed-beds, nor land known to be infested with charlock and other troublesome weeds. Either lime, or calcium carbonate, or calcareous beach sand should be applied in the winter as a precaution against club-root disease.

In the spring seed-bed preparation is done with a scuffle and harrows or a Rotary-hoe, the object being to secure not only a fine surface tilth but the good depth of pulverised soil that is essential to good root development.

Phosphate is an important factor in the early life of the plants, and seed-beds should receive a dressing up to 4 cwt. per acre of superphosphate (18 per cent P_2O_5). The soil requirement will vary, but can be determined by analysis. This phosphate should be applied before the final harrowing and firming of the seed-bed, and generally can be supplemented by $1\frac{1}{2}$ cwt. of sulphate of potash and 1 cwt. of sulphate of ammonia.

The seed of *Brassica* crops may be sown broadcast in beds about 4 ft. wide, or be drilled in rows. The latter method is preferable as it allows of weed control and produces sturdier plants with good leafage.

It is generally reckoned that 1 acre of drilled seed-bed is required for 16 acres of land to be planted. For cauliflowers of all types, kales, cabbage and brussels sprouts an allowance of from 6-8 lb. of seed per acre of seed-bed should be sufficient; this is based on the estimate that from 6-8 oz. of seed should normally provide sufficient plants for an acre of land.

More seed is required for broadcast sowing of seed-beds; the Cornish broccoli growers allow up to 12 oz. of seed for every acre to be planted when the seed is sown in this way.

The seed should be sown thinly but evenly. The small seed drills can be adjusted to sow at the desired rate, but broadcasting calls for individual skill. When broadcast sowing is practised the beds must be cast with fine soil from the alley-ways to cover the seed lightly. They should then be lightly rolled. When drills are used nothing further is required, though sometimes a light rolling is useful.

Flea Beetles are likely to be a nuisance in all *Brassica* seed-beds, attacking the seedlings as they emerge from the soil and also the cotyledons while germination is taking place. Attacks are less pronounced when the seed-bed is well prepared and a fertilizer is applied, for the plants then grow away quickly. A control of flea beetle is obtainable with Derris or DDT dusts applied with a dusting machine at appropriate rates per acre as soon as seed germination begins. Nicotine dust will also provide a control, but must be used in warm weather for good results.

Good plants for transplanting should be sturdy and possess a bold leafage of good colour and a good root system. Thin, 'leggy' and 'hard' plants are undesirable for transplanting.

Transplanting by Hand. Transplanting by hand follows two methods. The dibber method, by which a hole is first made and closed up with a dibber after the plant is inserted, is by far the most generally used. In some parts of the country, however, Devon and Cornwall for example, square-bladed spades and mattock-shaped planting irons are used. With the first type of

tool a hole is made sufficiently deep to take the plant up to the lower leaves by one man, and a second, the planter, inserts the plant and closes it in with the heel of his foot. It is claimed that this method is quicker than single-man dibber work. With the second method, the planting iron, which is a tool shaped like a mattock but small enough to be used in one hand, the hole is made with one hand, the plant inserted with the other and closed up with the heel of a single operator.

For cabbage crops the dibber is the best method for hand work and gives quick work under average conditions. Special care is needed when transplanting cabbage lettuce. The plants should not lies in shallow depressions after planting as this encourages disease. For lettuce the land should be marked out with lines and not with markers, which tend to leave depressions. In this way the plants lie perfectly level with the soil's surface after planting.

Leeks are always transplanted in a special way, deep holes, 4 to 5 in. deep, being made with the dibber into which the plant is inserted so that growth point is well below the surface.

Good growers always grade *Brassica* plants as they are drawn from the seed-beds, rejecting all with symptoms of Club-root, Gall Weevil and Root Fly infestation, and all blind, button-hearted, spindly or stem-twisted plants. In this way even plantings are obtained and the crop grows away uniformly. When mechanical transplanters are used uniform plants are particularly necessary to ensure satisfactory work.

During dry weather the plants may not 'draw' well from the seed-beds. Under such conditions the beds should be well watered before drawing begins, and the use of forks to lever up the rows of plants before drawing will be an advantage.

The Mechanical Transplanter. It is claimed that the mechanical transplanters do the work better than is possible by hand and many experienced growers state that the plants strike and grow away better when machine planted.

There are now available machines that can plant up to 12,000 plants per hour (10,000 is a good average), this comparing with a maximum of 600 for hand planting. The principle operations of these machines comprise the opening of a broad continuous furrow into which the plants are placed by rubber-clad fingers at the desired spacing. At the moment the plant is released

angled pressing wheels of the machine close in the furrow and consolidate the moist soil round the plant's roots. Devices for watering the furrow as the work proceeds are also now fitted transplanters. Four unskilled workers are required to operate the machine plus the driver of the tractor that hauls the machine. These transplanters will handle plants of tomatoes, celery, leeks, onions, as well as those of all the *Brassica* crops.

With celery, another important transplanted crop, great care is used in raising the plants which is done mainly away from the farm by specialist plant growers. The seedlings are first raised in frames, then given a first transplanting on to prepared beds in the open, termed 'bedding out'. From there, the plants when grown to the correct size, are removed to the farms and transplanted for the last time by hand or machinery. Many growers hold the view that hand planting is superior to machine planting and much is still done by hand.

Transplanting by Team Work. Hand planting of celery calls for team work, three men to a gang being usual. The first walks along the row with a long iron dibber known as a 'pog', which he drives into the soil with a twisting motion for each hole; the second drops a plant beside each hole and the third sets the plants, making each firm with his hands. On softer black fen soils where the 'pog' cannot be used so well, the plants are dropped by women at intervals along the rows. The planter follows closely on his knees making holes with a small wooden dibber into which he inserts and makes fast the plants as he goes along. This type of hand planting is a skilled art in which local workers become very proficient.

In the Cambridgeshire fens a shallow wide-shared plough, called a 'butterfly', is used to plough out shallow valleys rather than furrows, 4½ to 5 in. wide. The rows of celery then go up the centre of each valley on a firm bottom, some growers using dibbers and others machinery. Women lay out the plants.

Another practice in Cambridgeshire involves the use of a planting furrow that is taken out of the shallow 'valley' previously described, about 6 in. deep with one side vertical. The planter lays the plants in position against the vertical side of the trench and plants by pushing loose soil against the roots. A second man follows with a tool with which more soil is pulled against the plants from the sloping side without burying

the leaves. This type of transplanting is also effective, for from 22,000 to 25,000 plants per acre can be got in without difficulty.

Raising Plants under Glass. When raising plants under glass the grower has everything (temperature, moisture and soil) under control. In this connection the experimental work at the John Innes Horticultural Institution has demonstrated the value of suitably prepared composts both for raising seedlings and potting on. This information has been of particular value to the raisers of tomato plants.

The formulae for the John Innes composts are as follows :—

Seed compost.

2 parts sterilized medium loam	—	plus 1½ oz. superphosphate (18 per
1 part peat	—	cent P_2O_5) and ¾ oz. ground chalk
1 part coarse sand	—	or limestone per bushel of compost mixture.

Potting compost.

7 parts sterilized medium loam	—	plus ¼ lb. John Innes base mixture
3 parts peat	—	(see below) and ¾ oz. ground chalk
2 parts coarse sand	—	or limestone per bushel of compost mixture.

John Innes base mixture :—

2 parts hoof and horn, ⅛ in. grist (13 per cent. nitrogen).
2 parts superphosphate (18 per cent. P_2O_5).
1 part sulphate of potash (48 per cent. potash).

It is important to use a good texture loam that has been stacked for a period (6-12 months), to riddle it through a ⅜ in. sieve for the seed compost, and a ¼ in. for the potting compost, and to sterilize it with steam heat before using it for the composts.

Plants raised with the J.I. composts are normally twice as good as those raised by the old methods, using old types of mixtures, even when these mixtures are sterilized before use.

There are several ways of partially sterilizing soil. On a large scale this can be performed with a specially constructed steam apparatus. Steam is very satisfactory because overheating is impossible. With small quantities, sacks of soil may be suspended over boiling water in the ordinary type of domestic copper for from 30-40 minutes. Types of electric sterilizers are also available. The direct application of fire heat to soil (*e.g.* baking) should be avoided as more harm than good may be done to the soil. Electric sterilizers are marketed for treating soil, some types dealing with up to half a ton of soil at a time.

Seedling Treatment. It has been found that the treatment of seedlings has an important effect both on the type of plant raised and on the crop. With tomatoes, cauliflower, lettuce and other seedlings that have to be transplanted at least once before being finally planted, early pricking off of the seedlings is very important. The first pricking off should be done as soon as the seedlings can be handled. Seedlings should be handled carefully at all times; many losses occur through careless handling, due to disease organisms gaining entrance through lesions caused by damage.

Generally speaking, transplanted seedlings, including those pricked off, are set rather deeper than they were in the seed boxes. With some it is often an advantage to insert them almost up to the seed leaves or cotyledons. The same rule applies to plants transplanted on open land. Onions are are exception to this rule.

Chitting and Soaking of Seed—Vernalization. Although, generally speaking, it is best not to tamper with the natural process of plant development from seeds, the germination of seeds, and the production of seedlings, may be hastened by adopting certain measures, the chief of which are chitting, soaking, and vernalization. Chitting is especially useful in circumstances where a rapid and uniform seedling growth is desired, for example, the production of celery plants and mustard and cress. Soaking is a useful treatment for seeds sown in late summer under conditions where soil moisture has been reduced considerably and no rain is in prospect. Vernalization is a more complicated treatment, for it consists of partly germinating the seed and exposing it to low temperature.

When chitting seed, common practices are (1) to place the seed in a wooden receptacle (wood is better than metal for this purpose), moisten it thoroughly, cover it and place the receptacle in a warm temperature, *e.g.* over pipes in a glasshouse, repeatedly moistening the seed, until the seed swells and the first signs of sprouting appear. It is then carefully sown—sometimes mixed with dry sand or other material to facilitate sowing. Some growers mix the seed with Fuller's earth, sand, etc., before the preliminary moistening to hold the moisture. (2) The seed is placed between folds of cloth that are kept in a

moistened condition and placed in a warm temperature. This method requires more care as the sprouting seeds may become broken in freeing them from the cloth.

The germination of beans, peas, beet and other of the harder seeds is assisted by soaking the seed for about 6 hours (not overnight) in sufficient water to cover it in a pan. Soaked seed is, of course, more difficult to sow with a drill and must usually be dropped by hand, hence the practice is useful only for small-scale plantings. Carrot seed is also soaked on occasion; it facilitates germination during dry weather.

It is also worth noting that seeds of the *Brassica* crops, also of lettuce and carrots, may be assisted in germination by watering the drills before sowing. Even under very dry conditions in July and August successful sowings can be made by using this method, and a stand of plants secured.

Soil temperature is an important factor in the germination of seeds. Seeds of the *Brassica* crops, various root crops, peas and lettuce, will germinate freely at a soil temperature ranging from 45 deg. to 50 deg. F. Beans, tomatoes, marrows and cucumbers, however, are particularly sensitive to temperature and will rot in cold damp soils. These should not be sown until the soil temperature is much higher; hence the sowing of these crops in the open land must take place later in the season.

As regards vernalization, although much experimental work has been done on the subject, this type of seed treatment has not so far been generally adopted in commercial practice.

Raising Plants in Frames. Both cold and heated frames are much used for raising plants, particularly those of cauliflower, brussels sprouts, onion, celery, lettuce and tomato. Heating is usually obtained from hot-beds made from stable-manure, though experimental trials with electrically-heated beds have shown that such a method is a practical proposition.

The Dutch light is much used for over-wintering plants raised from seed sown in the autumn, such as cauliflower and lettuce. The ranges of lights are carefully set up on a sheltered site facing south, protected from cold searching winds. Each run of lights is on a prepared "bank" and is set at a pitch of about 25 deg., facing south, and the surface of the soil of the beds should also incline to match, and should come within 6 in. of the glass.

The seed is sown in finely-prepared soil and is covered by lightly sifting soil over it. The soil should be moist but not saturated at sowing time. Nor should it be dry, for if dry, the seed will not germinate well and give a good stand of plants.

Characteristics of Vegetable Seeds.

The data given below are intended as a rough estimate, and, while not to be regarded as absolutely accurate, are sufficiently reliable for vegetable growers to use as a guide.

Vegetable.	*Av. number of seeds per ounce.*	*Av. germination of good 1-year-old seed.*	*Statutory germination required under the Seeds Act. 1920.*	*Amount of seed required per acre (average).*
		per cent.	per cent.	
Asparagus ...	1,000	90	not scheduled	5 lb.
Beans, Broad ...	12	90	75	125-50 lb.
Beans, Dwarf ...	50—60	90	75	60 lb.
Beans, Runner ...	30	80—85	60	50 lb.
Beet, Garden ...	1,750	70—75	50 (of clusters)	4-6 lb.
Brussels sprouts ...	9,000	85	70	4-6 oz.
Cabbage ...	9,000	85	70	4-6 oz.
Carrot ...	20,000	70	50	4-8 lb.
Cauliflower and Broccoli	14,000	75	60	3-4 oz. for transplanting
Celery ...	60,000	70	not scheduled	1 oz.
Cucumber ...	1,000	90	do.	2 lb.
Endive ...	18,000	80	do.	8 oz.
Kohl-rabi ...	10,000	85	70	4 lb.
Leek ...	8,000	70	not scheduled	2 lb.
Lettuce ...	26,000	90	do.	1-2 lb.
Onion (for bulbing)	7,000	70	60	5-6 lb.
Onion (for bunching)	do.	do.	do.	20 lb.
Parsley ...	20,000	70	not scheduled	5-6 lb.
Parsnip ...	5,000	70	45	6-7 lb.
Peas ...	90-120	85	70	160 lb.
Radish ...	3,000	90	not scheduled	40 lb.
Sweet Corn ...	100-200	—	do.	6-12 lb.
Salsify ...	4,500	75	do.	8 lb.
Spinach ...	3,000	75	do.	20 lb.
Tomato ...	9,000	85	do.	1-2 oz.
Turnip ...	12,000	90	75	2-3 lb.
Vegetable Marrow	200-300	85	not scheduled	2-4 lb.

N.B.—The amounts of seed given above for Brussels Sprouts, Cabbage, Cauliflower and Leek are for seed-bed sowing only, i.e. for transplanting.

PART TWO

THE CULTIVATED CROPS

CHAPTER FIVE

The Cabbage Crops

Introduction. The cabbage crops are in the main varieties of the cabbage, a species of *Brassica* (*B. oleracea*) which grows wild in parts of Britain. Strictly speaking, therefore, the many so-called varieties of Brussels Sprout, Cauliflower, Cabbage, etc., are forms or strains of the respective varieties. They all have a chromosome number of 18.

Brussels Sprouts. This is one of the most popular winter vegetables, and, as the steadily maintained acreage of the last 20 years testifies, the demand from the consuming public is consistent. The annual area under brussels sprouts is such that the crop ranks as the third in importance amongst commercial vegetable crops.

Generally, the demand is for either a medium-sized or a large, firm sprout. The small "buttons" so popular on the Continent are less in demand in this country, but there is a limited trade from high-class restaurants and hotels for this type of sprout. The canners also prefer a small firm "button" type of sprout for canning.

From the grower's point of view brussels sprouts are one of the best cash crops, as the demand is fairly constant and prices seldom "slump" as badly as some other crops. In recent years, however, increasingly heavy attacks of aphis have rendered the production of good clean sprouts a difficult matter, and only clean produce is required on the markets. The grower who grows the crop well and makes an effort to control pests is usually well rewarded.

Types. Because of its extremely variable character, partly owing to genetical instability and partly to the freedom with which it cross-pollinates with other forms of the cabbage

family, the brussels sprout is not readily classified into well-defined varieties or types. During the last 60 or 70 years reputable seed growers have striven hard to maintain satisfactory stocks. It is recognized that stocks which are reasonably good when introduced by their raisers tend to degenerate after general distribution, so that the original standard is maintained only by constant re-selection and isolated seed production.

The ease with which the various stocks cross-pollinate, not only with other stocks of brussels sprouts but with cabbage, kale, kohl rabi and all other forms of *Brassica oleracea*, renders it extremely difficult to save true seed of any particular strain. Because of this it is rare to find a field of sprouts that does not contain a percentage of "off-type" plants or even plants of a hybrid character not resembling the normal Brussels sprout. It is fair to state, however, that within the limitations inseparable from the task the leading seed houses endeavour to maintain reasonably good strains, and if a crop of from 4 to 5 tons per acre can be reached with a good commercial stock the grower has little to complain about.

The Cambridge Horticultural Research Station has paid considerable attention to the task of developing improved types of brussels sprouts. A number of types have already been developed, and where they have been grown under farming conditions have proved their superiority over ordinary commercial stocks. It is clear from the work accomplished at Cambridge that permanent improvement in the strains of Brussels sprouts, as with other crop plants, must come about through the use of better breeding methods coupled with scrupulous care in seed saving.

It is possible to draw up a rough classification of brussels sprouts on the following lines :—

1. Dwarf types up to 18 in. in height.
2. Medium height types 18 in. to 24 in. in height.
3. Tall types over 24 in. in height.

Each group may again be divided into divisions based on the size of sprout as follows :—Small sprouts, below 1¼ in. in diameter; medium-sized sprouts, between 1¼ in. and 1½ in. in diameter; and large sprouts, over 1½ in. in diameter.

While there is little variation in the "season" of most commercial stocks, the Research Station at Cambridge, and the growers who have concentrated on developing their own

stocks, have paid particular attention to obtaining early, mid-season and late strains, thus enabling picking to commence from the end of August onwards, the last crop being cleared in the following March. The best of the Cambridge stocks are known as Cambridge Nos. 1, 3 and 5. They are of medium habit in growth, No. 1 being the earliest.

The commercial types of brussels sprouts are broadly represented by the Evesham type and the Bedfordshire tall type, variations in sprout size being found in different stocks of each. Stocks of the Evesham type bearing large sprouts are known as *Covent Garden*, *Fillbasket* (Sutton), *Evesham Special*, *Early Giant* (Clucas), *Favourite* (Clucas), and those bearing medium-sized sprouts are *XXX* (Harrison), *Favourite* (Dobbie) *Spiral* (of Dutch origin), *Aigburth*, *Cambridgeshire Champion*. Stocks of the Bedfordshire tall type bearing large sprouts are known as *Bedfordshire Prize*, *Evesham Giant*, *Harrison's Forex*, *Sharpe's Standard*, *Timperley Champion*. Stocks with medium-sized sprouts are known as *Darlington*, *Wroxton*, *Dalkeith* (a Scotch strain), *Veitch's Exhibition*, *Sutton's Exhibition*. Messrs. Yates's *Climax*, an excellent variety of the dwarf class, has been consistently reliable for several years.

Special mention should be made of the Continental "spoon-leafed" type which produces the small "button" sprouts popular with high-class restaurants. This type is known as *Imported* among English seedsmen. In France it is known as *Demi-nain de la Halle*, *Race de Rosny* (Vilmorin). The type is hardy and productive. It will doubtless be grown more in England as the demand for this class of sprout increases.

The following appear to be the salient points desired in good strains of brussels sprout for market cultivation:—

1. The growth should be hardy and resistant to frost injury and insect attack (some stocks resist aphis attack more than others).
2. The plants should not delay formation of sprouts and should form them uniformly.
3. The sprouts should be set closely, but not jammed together on the stem, so as to facilitate easy picking.
4. The sprouts should be large, compact and firm, preferably round instead of oval, and of a good green colour that is retained after cooking. (Cultivation and manuring also affect the colour of the sprouts).

5. The sprouts should keep well once they are formed, and not quickly burst.

It is often well worth while to attempt the raising of a special stock of brussels sprouts adapted for growing on a particular type of soil. Examples of this aspect of the question may be found in Worcestershire, where the Bretforton strain provides a noteworthy example. While other strains have failed this one succeeds quite well on the peculiar soil of the district. In practice we find that many large commercial growers of brussels sprouts have developed, by selection, their own special stocks of types that are suited to their soil, climatic conditions and market requirements, as well as adaptable for different seasons of gathering. In this way the grower is able to commence picking in early September, or even in August, and carry on all through the winter until the following March. Continuity of supply is a very important factor in "sprout" growing; it is essential to be in a position to maintain a steady supply throughout the season. An example of a grower's stock is *Rous Lench*, an early type, grown and distributed by N. F. Boswell of Ashchurch, Nr. Tewkesbury.

Soils. Brussels sprouts succeed best on loamy soils that are not too shallow. The crop has been successfully cultivated for many years on the light sandy loam of Bedfordshire, and lately with equal success on the loamy soils of Suffolk and Norfolk and the chalky soils of Wiltshire and Hampshire. Over-nitrogenous loose soils, such as fen-land, are not suitable as the plants become rank and produce many loose sprouts known as "blowers". On the other hand, the crop does very well on the stronger loams, such as Boulder Clay and the clay-with-flints overlying the chalk. Firm land is essential.

Raising the Plants. Normally, the plants are raised in a seed-bed and transplanted. Where, however, hot dry weather experienced in the early summer renders transplanting difficult many growers have adopted the plan, for at least a portion of their crop, of drilling the seed in the field and singling out the plants. For raising plants the seed is usually sown with a hand drill in the month of March on a well-prepared seed-bed, the rows being about 1 foot apart. For early crops (August and September pickings) seed is often sown in the early autumn and

transplanting done in the following April. For this the seed should be in by the end of August; as a rule the plants stand safely through the winter. Cold frames are very useful for the purpose of growing small quantities of autumn-sown plants, the lights going on only when the weather is severe. Another method of obtaining plants for early crops is to sow the seed in frames or under Dutch lights, or even in glasshouses, where a little heat is available, from January onwards. Continuous cloches may also be used for raising plants. Glasshouse plants, however, are apt to get very "soft" and so feel the move to outside conditions. As the important point with the brussels sprout crop is to ensure a long growing season, the sooner the plants can be put out after mid-April the better the growth and earlier the resultant crop. If the month of April is cold the plants will be late under outdoor conditions.

Seed Required. For seed-beds, from 4 to 6 oz. of seed should be allowed for each acre of land to be planted. An acre of seed-bed will take 6 lb. of seed, and should grow sufficient plants for 16 to 20 acres. For drilling in the open field where the plants are to stand it is customary to allow 1 lb. of seed per acre. To enable it to be drilled thinly the seed should be mixed with dry, sifted wood ashes. Surplus plants from the drilled land may, of course, be pulled out for transplanting to other land and for making up gaps. They may also be sold, many growers making enough in this way to pay for the seed. A good strain of seed is always worth the extra cost.

Land Preparation. The land should be ploughed well in advance of the crop, and on the heavier soils it should always be ploughed in the autumn, when any organic manure to be applied should be given. Farmyard manure is not always necessary; it is mostly required on the lighter soils, and after corn crops. The dung residues from a previous crop, or the application of from 30 cwt. to 2 tons per acre of a good shoddy, will usually suffice provided the land is in good heart. Good cultivations and the use of a well-balanced complete fertilizer are the chief factors in producing successful crops of brussels sprouts. Before the plants are set out the land should be well worked both ways to obtain a good tilthy surface-soil. A curved tine cultivator is the best implement for this job.

FERTILIZERS. On many soils phosphate is a significant factor in the manurial balance for brussels sprouts. Potash also imparts firmness to the growth and improves the quality of the produce.

In order to ensure that the crop has its needs fully met a fertilizer mixture approaching the 1-2-1 ratio should be used, and as a minimum from 800 to 1,000 lb. per acre of either a home-made mixture or a proprietary compound that gives roughly a 5-10-5 or a 5-10-6 analysis. For example, the last-named could be made up at home by mixing together :—

	200 lb. sulphate of ammonia	
	500 lb. superphosphate (18%)	
	100 lb. sulphate or muriate of potash	
Total	800 lb. =	Approx. analysis : 5% N., 10% P_2O_5, 6% K.

The fertilizer should always be well worked into the soil a few days before planting. On heavier soils many growers apply about 1 ton of soot per acre with good results; it appears to have a physical as well as a manurial effect on the land.

Top dressings during growth are important, either soot or sulphate of ammonia being used for the purpose. From 1½ to 2 cwt. of sulphate of ammonia or about 10 cwt. of soot should be used at a time, each top dressing being hoed in. As a rule either one, or two top dressings at intervals of about 6 weeks, is sufficient treatment for the sprout crop.

PLANTING. The land is usually marked out in squares ready for the planting, which is generally carried out by gangs on a "piece-work" basis, although an increasing use is being made of planting machines. The usual planting distance is 3 ft. × 3 ft., giving 4,840 plants per acre. It is important to see that the plants are well closed in, and not loosely finished off, when using the dibber. Watering may be necessary if transplanting is carried out in dry weather, and under such conditions it is a good plan to "puddle" the plants in. Watering should be done in the evening.

CULTIVATION. Several hoeings will be necessary during the season. Some growers use tractor-drawn implements, others horse hoes, but some hand-work is also necessary to clean

round the plants. Horse-drawn implements are really the best tools for cleaning sprouts, as unless skilfully used the tractor may cause damage to the half-grown plants.

GATHERING THE CROP. Marketing can commence as soon as there are sufficient good sprouts to handle. Many growers still use bags or nets, and submit the sprouts to a rough grading only. This involves putting the sprouts over a sieve as they come from the field and picking off the "blowers" and loose rubbish. Others adopt more thorough methods and not only make two sizes of the sprouts, but "dress" them over to make an attractive pack. Instead of bags and nets, non-returnable wooden crates and boxes and strawboard boxes are used. Whatever form of package is used it undoubtedly pays to make as good a grade as circumstances permit.

YIELD. Good growers expect to obtain a yield of 5 tons (400 boxes or bags of 28 lb.) per acre, but 3-4 ton crops are about the average.

COSTS. Brussels sprouts are an expensive crop to grow and market. While, of course, labour charges have since much increased, the following were the average figures for 5-ton crops under mechanized conditions in Suffolk and Bedfordshire during the 1930-40 period :—

Suffolk (light loam land).	£	s.	d.	*Beds. (heavy loam land).*	£	s.	d.
Total cost of production per acre	11	5	0	Cost of production per acre	15	0	0
Cost of picking : 400 boxes at 5d.	8	6	8	Cost of picking : 400 bags at 8d. ...	13	6	8
Cost of boxes : 400 at 6d.	10	0	0	Transport to London (16/- per ton) ...	4	0	0
Cost of grading at 2½d. per box	4	3	4				
Transport by lorry to London (12/- per ton) ...	3	0	0				
	£36	15	0		£32	6	8

N.B.—The above figures do not include salesmen's commission, market tolls, hire of bags or any item for farm office charges and clearing the land.

CLEARING THE LAND. After the crop is finally cleared of everything saleable (brussel-tops are always saleable and sprout "greens" are often in demand in March and April), the stems are either chopped off at ground level and ploughed in with the roots or are forked out and carted off the land. Some growers fork the stumps out and have them laid in the furrows in front of the plough, while others compost them with straw and manure. In the sheep districts sheep are put on the land to clear the greens. The expense of clearing the land of stumps is quite an item of expenditure and should, of course, be charged to the sprout crop account.

Broccoli or Winter Cauliflower. This Brassica crop also works into the rotation of mixed farming very well indeed, so that farmers in Kent, Devon and Cornwall—the favoured broccoli districts—have developed it considerably in recent years.

PLACE IN ROTATION. Broccoli is an exhausting crop and most types of arable land, particularly land suspectible to drought, should always be well manured for it. It therefore provides a good following crop for any of the cereals, or it may follow a short ley. It is also a good crop to follow a "fouling" crop of the previous year where a "half-fallow" is required for cleaning purposes. Under market gardening conditions broccoli can follow a well-manured early potato crop or early peas.

As it is the Brassica crop that requires the longest period of growth, up to 10 months on the land with some types, it is apt to disturb cropping routine a little. On some farms if preliminary cultivations are taken into account, the land is occupied for upwards of 15 months with the broccoli crop.

Modern varieties of broccoli produce fine large heads equal in size and quality to the best cauliflowers (see Fig. 15). While there are a few early winter or late autumn types, such as *Veitch's Self-Protecting*, most of the types turn in from January onwards, depending on the district. Although hardy, the plants sometimes suffer severely from winter killing, and "leaf-drop" in cold districts is apt to have a serious effect upon crop prospects. Broccoli is really successful only under the mildest conditions, which is why the crop chiefly centres in Devon and Cornwall.

TYPES. During the past twenty years the types of broccoli grown for market have undergone a change. Before the advent of tariffs the strong competition from Brittany tended to displace the English produce. The Roscoff type of broccoli sent over, a local Brittany type, more hardy than the Angers type, was infinitely superior to the poorly coloured, flat-headed English types. As a result of steps taken to acquire and develop the best strains of the Roscoff type, and the attempts made by breeding methods to improve the existing English types, there is now a wide range of good broccoli. As the markets require in broccoli solid, conical-shaped, large white heads, it is therefore useless to grow the old flat, badly-coloured types.

Modern Varieties of Broccoli. During the last 20 years efforts have been made to improve the varieties of broccoli suitable for cultivation in Britain, using the French Roscoff and Angers types. This was not so simple as it might appear as it involved breeding strains that would withstand the varying climatic conditions of different districts. For example, a strain that may do quite well in Devon and Cornwall would most probably fail in the Eastern Counties.

Thus at the Cambridge Horticultural Research Station attention was directed to the problem of obtaining strains that were of hardy constitution and gave good foliage protection to the curd. At Seale Hayne College strains suited to the milder conditions of the West were mainly the objective. The result of this work is a short list of useful strains of broccoli suitable for maturing in the early months of the year when the demand is keen. Although supplies of seed are limited efforts are being made to work up stocks. These strains are known as:

Cambridge 5X maturing February—early March.
„ 426 „ February—early March.
„ 3X „ end of February—March.

Seale-Hayne A6 maturing January—early February
„ B.1 „ January—February.
„ No. 3 „ February—March.
„ DK7 „ March.
„ No. 5 „ April.

The Cambridge strains are hardy, bred to withstand low temperatures and damp conditions, and afford good foliage protection to the curd. The Seale Hayne stocks are better

suited to milder conditions, such as are found near the sea or on sloping land where there is good cold air drainage.

Broccoli in Cornwall. In the mild broccoli growing district of Cornwall a full range of cutting extending over several months is obtained by planting a selection from the following :

Walcheren (really a late cauliflower), maturing		September—October.
Veitch's Self Protecting	,,	November—December.
or		
Tonkin's November Heading	,,	November.
Tozer's December Heading	,,	December.
Seal-Hayne A. 6 (Roscoff No. 1)	,,	December—January.
Early Feltham	,,	January—February.
Seal-Hayne B. 1 (Roscoff No. 2)	,,	January-February.
Morse's January (Roscoff type)	,,	January.
Jeffrey's Roscoff	,,	January.
Morse's February (Roscoff type)	,,	February.
Fairweather's No. 2 (Selected Roscoff)	,,	February—March.
Penzance Early White	,,	February—March.
Selected Roscoff No. 3	,,	March.
*Seale-Hayne D.K.*7 (Roscoff No. 4)	,,	March—April.
Seale-Hayne No. 5 (Cross between Angers and Roscoff types)	,,	April—May.

Note.—Inquiries regarding these modern varieties of broccoli should be made through any of the well-known seed firms catering for the industry. Messrs. P. H. Tonkin Ltd., Truro, Cornwall, handle all the types of broccoli mentioned above.

A Recommended List for Average Conditions.

For October-November cutting	*Michaelmas White* or *Veitch's Self-Protecting.*
For November-December cutting	*Winter Mammoth.*
For January cutting	*Snow's Winter White* or *Backhouse's Winter White.*
For February cutting ...	Earliest types of *Roscoff, Penzance, Early Feltham.*
For March cutting	Second early types of *Roscoff, Adams's Early White, Mid-Feltham, Monarch.* (Fig. 12).

For April cutting ...	... Late types of *Roscoff, Leamington Late Feltham, Knight's Protecting, Evesham Giant, Elletson's Mammoth, April Queen, St. George.*
For May-June cutting	... *Cattell's Eclipse, Late Queen, Late Feltham, Clucas's June.*

The cutting season even of the hardier types will vary according to the district, and in exceptionally mild seasons varieties tend to fall out of their season and come in together.

Land Preparation. Successful growers of broccoli believe in a thorough preparation of the land for the crop. Although the plants are not put out until May, June or July, according to the type and the district (later planting is practicable in Devon and Cornwall), the land is usually well ploughed and manured a few months ahead, the heavier land being ploughed and laid up roughly the previous sutumn. The best crops are grown on well consolidated land partly because recently-ploughed land is "puffy" and dries out more quickly. From March onwards the land should be well cultivated, whenever dry enough, to obtain a good surface tilth free from weeds by planting time.

Manuring. Good broccoli cannot be grown on poor land and in almost all instances an application of from 12 to 20 tons of farmyard manure should be ploughed in. Many of the favoured broccoli districts are on the seaboard, and growers cart seaweed, a valuable fertilizer, and mix it with the manure. and Cornish beach sand. If the land is in fairly good heart shoddy, 30-40 cwt. per acre, may be ploughed in instead of farmyard manure, or 15 cwt. of hoof and horn meal per acre may be worked into the surface at the first spring cultivation. Much as the success obtained by Cornish market growers is due to the liberal use of beach sand containing calcium carbonate as high as 85 per cent. It is removed from the beaches under a right conferred by ancient charter and is applied at rates of from 3 to 6 tons per acre.

Fertilizers. In general, the use of a complete fertilizer is necessary to obtain the correct type of growth and curd development. Phosphates are very important, and potash strengthens and hardens the growth, thus safeguarding damage from both "frost kill" and the climatic trouble known as "leaf-drop".

As a basic dressing before planting, from 800 lb. to 1,000 lb. of a 6-12-6 or an 8-16-8 fertilizer should be well cultivated in. During the growing season top dressings are given as often as required. For autumn crops the top dressings should be applied in July or August, but for overwintering crops they are best held over until growth is again on the move from mid-January onwards, according to variety and district. From 1 to 2 cwt. of nitrate of potash per acre or a mixture of 2 cwt. sulphate of ammonia and 1 cwt. muriate of potash per acre will provide a good top dressing for broccoli crops.

Raising the Plants. The plants are raised in well-prepared and manured seed-beds, the seed being either hand drilled in rows 12 in. apart during March or April, or sown broadcast in beds about 4 ft. wide. Half a pound of seed is usually allowed in beds of about 4 ft. wide. Half a pound of seed is usually allowed for each acre of land to be planted. Every effort should be made to raise good, strong plants of broccoli, for this is the secret of success with this crop.

Planting. Planting is done during June and July, according to district, any time after mid-July being too late even for late crops. The land should be marked out in 28 in. or 30 in. squares, giving roughly 7,000 plants per acre. The plants should be inserted up to the lower leaves and made very firm with the operator's heel or the dibber, firm planting being important. In dry weather the plants should be puddled in when water is available. At the time of planting a driving road across the field should be left unplanted or planted with an earlier maturing crop; this will enable the crop to be carted off the land with ease.

Cultivation. Cultivation should go on until it is found that the land is getting full of the plant roots, usually in September. From three to four horse hoeings and some hand work will usually be required during the summer to keep down weeds. After September many growers bank up the plants with a banking plough for the sake of protection and to provide drainage, the ridge and furrow running in the same direction as the slope of the land—if any.

Gathering the Crop. The heads of broccoli should be cut as they turn in. A sharp butcher's knife is the best tool for

cutting. The heads should be trimmed and graded according to size, all discoloured or "frothy" heads being discarded. The best package for market is the wooden crate, in which the heads are packed on their sides, curd inwards.

Observations. From the foregoing it will be evident that broccoli is an expensive crop to grow. As a mediocre lot of broccoli does not pay, the crop should either be done well or left alone. A point to remember is that good heads cannot be grown on poor thin-stemmed plants, and only good cultivation and manuring will produce good plants.

Cauliflowers. Although late summer and autumn cauliflowers have always been an important market crop it is only during the last 20 years or so that the production of early summer cauliflowers has received increasing attention. Formerly both Holland and Belgium made a special business of producing early cauliflowers for export to Great Britain but English growers have now mastered the practice and substantial quantities are being grown every year. The production of each type of cauliflower crop will be dealt with separately. There are several classes of cauliflowers. Those generally grown are known as Northern or Danish, Parisian or French, the Algiers and the Italian. The last-named is a good maincrop type of cauliflower, maturing in about 5 months from time of sowing. Good cauliflowers cannot be grown on poor land.

1. Early Summer Cauliflowers.

The successful production of this crop requires the aid of glass; either Dutch lights or ordinary frames can be used. It is thus a crop that works in with the cropping system of intensive market gardens where a large unit of frames or Dutch lights is maintained. See Figs. 34 and 35 for an example of a frame unit.

Types. For early summer crops the small- and medium-sized Northern and Parisian types of cauliflowers, that mature quickly, are grown. *All the Year Round* (*Driancourt*, *All Seasons*), *Extra Early Parisian*, *Le Cerf*, *Remme*, *Snowball*, *Imperial*, *White King*, *Cambridge Early No.* 5, *Early London* are some of the best.

Raising the Plants. The seed is sown thinly under the Dutch lights or in frames during October, and when large

enough to handle the seedlings are pricked out in other frames or potted up in small, 60 size, pots. The plants should be carefully treated throughout the winter, the frames being given air on mild days and protection by covering with straw or mats during spells of severe weather. Watering should be carefully done to avoid loss through mildew and "damping off". In some districts it is the practice to over-winter cauliflower plants in cool glasshouses. The plants are potted up and heat is turned on only when there is a risk of frost.

Land Preparation. A piece of good land should be prepared for early cauliflowers by ploughing and manuring it in the autumn or early winter. A good dressing of farmyard manure is essential, 20 tons per acre being not too liberal.

Transplanting. The plants are planted out in mid or late March, by which time the risk of severe weather is past. These smaller types may be planted in rows 24 in. apart with 18 in. between the plants, giving about 14,000 plants per acre. A dibber is usually employed for the plants drawn from the frames, but a trowel should be used for the plants grown in pots. It pays to take pains with the transplanting. Very early cuttings of cauliflower are secured by putting out plants in Dutch lights or under cloches in conjunction with early carrots, turnips, etc. (see Chapter XII), the protection being removed when the plants have made growth and the other crops are cleared.

Fertilizers. An application of soot, 10 cwt. per acre, well cultivated into the surface before planting, is a good growth stimulant. On lighter soils phosphate and potash are effective fertilizers. When working down the land for planting, a mixture of 500 lb. of superphosphate (18 per cent) and 100 lb. of sulphate or muriate of potash per acre should be broadcast. When the plants are established soot can be given as a nitrogenous stimulant. Only well-grown, bright and fresh heads of cauliflower are wanted, and it is the skilful use of manure and fertilizers that ensures this type of production.

Irrigation. Spells of hot dry weather in May tend to check the growth of early cauliflowers. If badly checked the plants tend to "button", i.e. form small premature heads of no

market value. Many growers now use overhead irrigation to guard against this occurrence. Under irrigation methods the plants grow steadily and develop naturally.

Cutting and Marketing. Early cauliflowers are usually ready from the end of May onward, the earliest being the frame-grown. The heads should be cut in the early morning or late evening. Each head should be carefully trimmed and graded for size and colour. Wood crates are the best package for high-grade early cauliflowers. These cauliflowers are smaller than the late summer and autumn types and a standard size crate will usually hold from 24 to 36 heads comfortably.

2. Summer Cauliflowers.

With the aid of Dutch lights for raising the plants a crop of cauliflowers for cutting in July can now easily be secured. The seed is sown fairly thinly in the frames towards the end of March, and the plants which are gradually hardened off are ready for transplanting at the end of April or early in May. The beds should be made up and the lights kept on the frames for a few days before sowing in order to warm the soil, because cauliflower seed is apt to lie and rot in cold soil. Another, and safer plan, is to "chit" the seed in a warm greenhouse before sowing it; it then comes up very quickly.

Plants raised in Dutch lights should be carefully watered, and also well ventilated on fine warm days. The lights should be removed during the day time a week or so before transplanting in order to harden the plants gradually.

A good type for summer cropping is *All-the-Year-Round* or *All-Seasons*. *Imperial* and *Eclipse* (Dutch type) and *Reliance* (Parisian type) are also useful, standing hot weather well. It is a hardy, quick-growing plant, yielding compact, finely-grained heads. *Le Cerf* is also a good variety to mature in the August-September period.

General cultivation details for this crop of cauliflowers are similar to those for the early crop. The land should be well prepared. Autumn ploughing and manuring followed by spring cultivations at intervals form an excellent preparation. This crop greatly benefits from irrigation.

Marketing. This crop is likely to come into competition with other green crops, peas and beans. In order to secure

the best possible market prices the heads should be carefully graded and packed, all blemished and low quality heads being discarded.

3. Late Summer and Autumn Cauliflowers.

This crop is grown entirely in the open, the plants being raised from seed sown in seed-beds in April and transplanted in May and June, and even July, for late crops.

Place in Rotation. This cauliflower crop is often fitted in after the land is cleared of an early crop such as early potatoes, early peas, or even a crop of spring cabbage. It is, however, not always wise to treat the crop as a catch crop. If they are to be successful cauliflowers require good treatment.

Soils. This crop does best on deep, loamy soils that hold moisture. The lighter soils are too subject to drying out, and this causes a check to the plants, an important point with all cauliflowers. The land should be well manured for this crop.

Types. The Italian (Fig. 16) and Northern types of cauliflower are most suitable for late summer and autumn crops. There are both early and late varieties of these types.

For early and mid-season cutting	Italian Type—*Eclipse* (mid. August), *Early Naples*, *Early Autumn Giant*, *Primus* (late August). Northern Type— *Danish Giant*, *Erfurt*. Parisian Type—*All-the-year-round* or *All Seasons* (late August).
For late cutting	Italian Type—*Veitch's Autumn Giant*, *Neapolitan*, *Enkhuizen Market*, *All Saints*, *Autumn Mammoth*, *Majestic* (September and October). Northern Type—*Walcheren* (October).

Eclipse is one of the earliest of the Italian cauliflowers, giving long-stemmed plants with white, finely-grained head. The foliage does not protect the head very well and the leaves should be broken over it to prevent discoloration. Both the *Early* and late *Autumn Giant* develop good, well protected white heads. Both *Danish Giant* and *Erfurt* are good dry-weather cauliflowers not prone to bolting. They are also good sorts of cauliflower for pickling. *Harrison's Novo* is also an excellent late cauliflower.

The *Walcheren* is a hardy type and can be regarded as in broccoli class. A good type of cauliflower for market is one that stands up well to dry weather and develops a well-protected compact, white head.

Raising the Plants. April is a good month for sowing the seed of late cauliflower, the earliest sorts early in the month and the later kinds towards the end. The seed is sown in a well-prepared seed-bed and the plants are put out as soon as large enough to handle. It is well not to retain "leggy", over-drawn or "hard" plants, as these are not likely to be so successful.

Transplanting. The plants should have plenty of space in which to develop. The rows should not be closer than 28 in. for the stronger types (36 in. would be better), and the plants at least 24 in. apart. Firm planting is essential. The planters should be carefully watched, for bad planting may spoil the crop's chance of success. In dry weather it is a good plan to "puddle in" the plants when planting them if water can be found for the job. If any plants go off—and some loss from various causes is always experienced—the gaps should be made up without delay.

Cultivation. The land between the rows should be frequently moved while growth is active, and all weeds kept down, until the soil becomes full of roots when it should cease. In dry weather this crop also benefits from irrigation.

Cutting and Marketing. As the plants commence to turn in it is worth while going over the crop at intervals to break a leaf or two over exposed heads to prevent discoloration. This is more necessary for August and September crops than for later crops. The field should be gone over at frequent intervals to obtain all the heads suitable for cutting as they turn in. Two or three times a week may be necessary in growing weather. High-grade cauliflowers are best packed for distant markets in non-returnable crates; each head should be carefully trimmed. Many growers in the vicinity of large towns load them loose, without trimming, into lorries to save excessive handling, while others use large returnable boxes; it all depends on the class of trade.

FIG. 24.—A good type of market cabbage lettuce : *Clucas's Borough Wonder.*

FIG. 25.—Packing lettuce for market in the field.

FIG. 26.—Hand hoeing a field of early lettuce.

ASPARAGUS GROWING FOR MARKET.

FIG. 27.—The wide bed system. Forking over the beds in March.

FIG. 28.—Grading the "grass."

FIG. 29.—Bundling the "grass."

FIG. 30.—Asparagus growing : packed crates ready for despatch.

FIG. 31.—A popular type of white market celery : *Market White*, known as *Curly White* in the London markets.

Cauliflowers for Pickling. At one time supplies of specially grown cauliflowers, termed by the trade "foreign specials", were imported to a considerable extent from the Continent and were utilized in the preparation of high-grade pickles. Home supplies were drawn largely from the crops of the *Italian type e.g. Veitch's Autumn Giant* which, while it yields a percentage of suitable heads, is on the whole unsuitable for crops grown specially for pickle-making because the percentage of curd to stem and leafage is small. The pickling factories require the curd only.

Experimental work at Kirton, Lincs, revealed that the *Northern type* provides a good curd for pickling of which *Danish Giant* is equal in quality to the imported "foreign specials" alluded to above. This type is not, however, so easy to grow as *Veitch's Autumn Giant*, and under unfavourable conditions it is subject to "buttoning". Irrigation can, however, be used to overcome the drought conditions usually responsible for much of the "buttoning."

Crops of cauliflower for the pickling trade should be grown as a main crop, and not as a catch crop. The preparation of the soil should begin early and tillage be maintained up to the time of transplanting. Land in good heart and structure, and well supplied with natural moisture, is essential to success, as the growing plants must not be subjected to any appreciable check at any stage.

THE VARIETY. It is known that stocks of *Danish Giant* vary considerably both in quality of the curd and in yielding capacity. "Buttoning" is also more pronounced in some stocks than in others. A good stock, the best obtainable, should therefore always be grown.

SEED AND SOWING. The seed should be sown in late April or in early May. On an average more favourable transplanting conditions are secured by earlier sowings. If the crop is to succeed an earlier one, such as spring broccoli or cabbage or early potatoes, sowing must needs be adjusted to provide the plants at the correct stage for transplanting when the land becomes available. It is a great mistake to leave the plants in the seed-bed after this stage, for this also encourages "buttoning". Late sowings are not to be despised; sowings even as late as the first week of June have given satisfactory crops.

Experimental sowings at Kirton gave interesting results :—

	Yield of trimmed heads.
First sowing—April 17 ...	... 1 ton 7 cwt. per acre.
Second sowing—May 19	... 2 tons 14 cwt. per acre.
Third Sowing—June 4 ...	... 3 tons 4 cwt. 56 lb. per acre.

The low yield from the earlier sowing was due to the excessive "buttoning" and the poor stand of plants resulting from unfavourable transplanting conditions.

Transplanting. This may be done by either hand or machine. Comparatively close planting is advisable as the yield in weight per acre is thereby raised. At Kirton it was found that planting 18 in. x 18 in. gave a yield of 3 tons 4 cwt. 56 lb. of first-grade trimmed heads per acre as compared with a yield of 2 tons 3 cwt. 15 lb. from a planting of 24 in. x 24 in. Against the higher yields from closer planting must, however, be set the additional cost of crop cleaning, more hand work being necessary.

Cleaning the Crop. The growing crop must be kept free from weeds, but surface tillage of the soil should be very carefully carried out after a certain period as the soil becomes full of feeding roots. The crop can easily be checked by unjudicious tillage. After a time it is better to scrape hoe between the rows rather than to loosen the soil.

Harvesting the Crop. As cropping extends over a period the field should be cut over daily when the crop begins to turn in. If done at longer periods a proportion of the heads may lose the first-grade pickling quality and will have to be graded as seconds. If the daily cutting is not large enough to dispatch separately (usually possible only with large acreages) the curds are brined on the holding and dispatched to the factory later as convenient. The curds are placed in large casks, usually hogsheads, with brine, the brine being run off before dispatch to the factory.

Growers proposing to produce crops of cauliflowers for the pickling trade are advised to make advance contracts with pickle manufacturers, as the speculative production of high-grade produce of this type is risky. Contracts, too, should be carefully examined so that the commitments involved and the price to be paid are clearly understood.

Cabbages. Cabbages are grown commercially for human consumption on a very large scale in Great Britain; they rank as one of the three most important vegetable crops, the others being brussels sprouts and green peas. The cabbage group includes savoys, and in a normal season cabbage of one type or other is on sale for at least 10 months of the year.

PLACE IN ROTATION. Although on intensive vegetable farms a crop of cabbage often follows autumn cauliflower or spring broccoli, it is wisest not to take Brassica crops too often on the same land. Under farming conditions cabbage can follow early potatoes, beans, peas and also a corn crop. Because of the various types, with their different seasons of growth, the cabbage crop lends itself very well to a general scheme of cropping, as, provided the land does not carry a Brassica crop too frequently, it can be fitted in to suit convenience.

CLASSES OF MARKET CABBAGE. There are four main crops of hearted cabbage grown for market. These are :—

Spring cabbage.
Summer and autumn cabbage.
Winter cabbage.
Savoy cabbage (also a winter crop).

There is also a trade for "cabbage greens" in the early months of the year. This commodity mostly consists of small unmatured cabbages grown thickly in rows without transplanting, but sometimes it is the produce of stump plants.

Spring Cabbage. This crop is grown from seed of special types sown in the late summer of the previous year. In a normal winter the crop stands well, but abnormally severe winters are apt to cause severe damage except in favoured districts.

Summer and Autumn Cabbage. This crop is grown from seed sown early in the same year. From seed sown in March a crop can usually be cut from mid-July onwards.

Winter Cabbage. Types of hardier cabbage constitute this class. From seed sown in May and June crops can be cut during November, December and January, according to the type grown.

Savoy Cabbage. A distinct type of very hardy cabbage; it will stand up to 15 or 20 degrees of frost. From seed sown in

April, May and June, crops can be cut from November onwards through the winter.

Types of the above classes in general cultivation are :—

Spring Cabbage—Early, conical-headed type : *Early Durham, Ellam's Early Dwarf, Harbinger, Wheeler's Imperial, Sutton's April, First Early Market, No.* 218 (*Clucas*).

Second early, conical-head type : *Flower of Spring, First and Best, Early Offenham, Evesham Early Market.*

Summer and Autumn Cabbage—Large conical-headed type : *Early Ranham, Enfield Market, Winnigstadt, Daniel's Defiance.*

Flat, ball-headed, Danish or Dutch type : *Copenhagen Market, Golden Acre, Primo, Utility, Up-to-Date.*

Dwarf, compact, conical-headed type : *Dwarf Nonpareil, Tovey's Nonpareil, McEwan's Early.*

Winter Cabbage—*Danish Ball Head, Christmas Drumhead, January King.*

Savoy Cabbage—Dwarf, compact type : *Dwarf Green Curled, Early Dwarf Ulm.*

Large, flat type : *Best of All, Drumhead Early, Drumhead Late, Ormskirk Early, Ormskirk Late.*

Soils. Cabbage is considered a gross feeding, moisture-loving crop, and does best on loamy soils in a good condition of fertility. Both summer and winter crops of cabbage can make use of large amounts of nitrogen derived for preference from organic matter provided either by direct application or a residues from a previously manured crop. The spring crops do best on lighter loams which warm up quickly in the spring. The summer and winter crops do better on stronger and deeper loams that hold moisture.

Land Preparation. It is not always necessary to plough for spring cabbage, as the land after early potatoes can often be disc-harrowed or worked with a cultivator into a good condition for planting. It is worth noting that autumn-planted cabbages are better if on fairly firm land. The land for summer and winter cabbage should, on the other hand, be well ploughed as deeply as possible, the heavier land being ploughed during the winter and left rough.

Thorough cultivations before planting are also essential. The chief object is to provide rooting conditions under which the plants will grow and develop without check.

Manuring. Manurial practice for cabbage crops varies considerably according to the land, etc. While spring crops

can be grown on an artificial fertilizer dressing some amount of farmyard manure is usually advisable for summer and winter crops. For the latter a part manure and part fertilizer treatment is often successful. For example, a treatment of 10 tons of farmyard manure per acre supplemented with a good dressing of a complete fertilizer, high in phosphate, such as 4-12-4, and 4-16-4 analyses, should give satisfactory results. On land receiving no manure for the crop a complete fertilizer such as that of the 1-2-1 ratio should be used. On the basis of an analysis of 5-10-5, from 600 to 1,000 lb. of fertilizer mixture, supplemented with from 6 to 10 cwt. of hoof and horn meal, per acre, should produce a good crop of cabbage.

Cabbage crops respond well to nitrogenous top dressings. They should be applied in the early spring for spring crops and six weeks after planting for summer and winter crops. Such treatment should take the form of from 150 to 200 lb. of nitrate of soda, nitro-chalk, nitrate of potash or sulphate of ammonia per acre. The nitrate of potash is very useful for winter crops as the potash hardens the growth and imparts a good green colour to the heads. It is also a good top-dressing for spring cabbage if applied about February.

Raising the Plants. The plants are raised in prepared seed-beds. The seed of crops for spring cutting should be sown outside about July 21, and the seed of summer, autumn and winter crops outside during March, April, May and June. For winter crops the sowing requires careful timing according to the district. Many winter crops of cabbage and savoys are sown too early.

Early crops of summer cabbage can be obtained by sowing seed in cold frame or under Dutch lights in late February or early March. This is often well worth while if the over-wintered crops have fared badly and cabbage is likely to be in demand.

Roughly half a pound of seed should be allowed for each acre of land to be planted. When the seed is drilled in the field, as for crops of cabbage greens, from 5 to 6 lb. should be allowed.

Transplanting. The planting of the spring crop should be completed by the end of October. September is a good month for planting in most districts. In very cold districts it is customary to winter the plants in the seed-beds and transplant

them in the spring, but these crops are, however, later than the average.

In determining the planting distance for cabbage, such points as the type of cabbage used, the type of land and the manuring given should be taken into account. For the smaller, earlier types spacing the rows from 24-30 in. apart, with plants from 12-15 in. apart, should be suitable. For the larger later types, such as Drumhead, the rows should be from 30-36 in. apart, with the plants 15-18 in. apart. In general it may be said that while total yields are increased numerically with closer planting, the individual size of the head tends to be smaller. There is thus little gain in weight per acre. Rows 24 in. apart, with plants 18 in. apart, give a planting of 14.000 plants per acre. Cabbage planting is performed by gangs working on the piece-work basis, or it may be done with a mechanical transplanter.

Cultivations. The land should be kept clear of weeds by horse hoeing and cultivating when necessary. Top dressings of fertilizers should be cultivated in. Some hand work is necessary to clear round the plants.

Cutting the Crop. Much of the acreage of spring cabbage is often cut in a semi-hearted condition if the trade happens to be good. Summer and winter cabbage, on the other hand, should be well hearted, but not split, when it is cut. Good market cabbage should possess externally a fresh deep green colour, and savoy cabbage, particularly, should be of a good, deep green. Cabbage is dispatched to market in a variety of packages. Wooden crates are a useful package for good quality cabbage. Bags, holding either from 30-40 lb. or from 60-70 lb., have long been popular for semi-hearted cabbage and cabbage greens. Coir nets are often used for large, good-hearted cabbage.

The Production of Cabbage Greens. There is often a good trade in the early months of the year for cabbage greens. This term is applied to young unhearted cabbage, grown from seed sown in late summer, July-August period. Some growers drill the crop thinly in land where it is to stand; others raise the plants in seed-beds and transplant them to prepared land, putting them out as thickly as possible, e.g. 15 in. or 18 in. apart in the rows and 9 in. between the plants—roughly 46,000

plants to the acre. This crop does very well after second early potatoes, or any other non-brassica crop that has been cleared, provided the land is not foul. A good working with the disc cultivator, followed by the harrows, is usually sufficient preparation for cabbage greens.

Types for Sowing. The small compact forms of spring cabbage are the best for cabbage greens. For cutting before Christmas the old *Meins No.* 1 is a useful variety. *Ellams Early* and a good strain of *Early Offenham* are suitable for sowing in the open to stand the winter. For drilling, 5-6 lb. of seed per acre should be allowed. For plants in the seed-bed for transplanting thickly, about 2 lb. of seed should be allowed for each acre to be planted.

Fertilizers. If cabbage greens are grown on the manurial residues of the previous crop it is seldom necessary to apply further dressings of fertilizers, especially as nitrogenous substances render the plants more subject to frost damage. A light application of 300 lb. of superphosphate and 100 lb. of muriate of potash per acre is worth applying on the lighter loams, as it imparts a good colour to the greens. It should be put on before the drilling or planting is done.

Cutting and Marketing. Cabbage greens are cut and dispatched to market in bags whenever the demand is good. As a general rule the land is cleared, but it sometimes pays to go over the crop several times, taking the largest plants each time.

Kale. The curled types of kale or borecole, sometimes referred to as Scotch kale, ar grown for market to a fair extent and usually meet with a keen demand, especially in the event of other green stuff becoming short. It is very hardy, so standing the severest winter conditions; this factor being an additional feature in its favour. The *Cottager's* and *Thousand Headed* kales are also sometimes grown for sale, and during times of scarcity meet a good demand. The latter is really a farm type of kale, though when green crops are scarce it is often marketed for human consumption. *Hungry Gap* and *Asparagus* kales are distinct forms of kales with a different genetical constitution. Having 38 chromosomes, the are regarded as of ' double

hybrid'' origin, derived from the cabbage and turnip groups. The swedes are in the same category.

VARIETIES. There are really only two varieties of Curled Kale, Green Curled Tall and the Green Curled Dwarf, but there are several good strains of each, the seed of which is carefully saved from year to year; these should be selected for cultivation.

RAISING THE PLANTS. Requiring a good season of growth Scotch kale should be sown in late March or early April. The plants should be set out in June in rows 2 ft. 6 in. apart, with 18 in. between the plants for the dwarf varieties and 2 ft. for the tall varieties.

CULTIVATION. Scotch kale is a useful crop to follow early potatoes lifted in June. After the first potato crop is cleared the land should be harrowed down and made as firm as possible. If the potatoes were well manured, fertilizer may not be necessary, otherwise a complete cabbage type of fertilizer containing a fair amount of potash should be applied. Potash hardens the growth and imparts a good green colour to the kale.

MARKETING. The heads of kale are generally selected in the field and cut as they become ready. The crop is usually marketed during the period January to March according to demand. After April the kale ''bolts'' and is then unsaleable.

Bags, holding from 30-36 lb. are generally used as a market container, but wicker and wooden containers preserve the freshness.

Cabbage for Pickling.

Red Cabbage. Red varieties of cabbage chiefly are grown for pickling, although they are also a good table vegetable. There is a omewhat limited trade for supplies for private pickling, through the usual trade channels, but the pickle manufacturers usually obtain their supplies from growers on the contract basis. Large quantities of cabbage for pickling were annually imported from the Continent.

VARIETIES. Only varieties that develop a deep blood red colour should be grown for pickling. One of the best sorts is the small Dutch variety called *Erfurt Blood Red Early* or *Red*

Dwarf Dutch. This variety is early, of dwarf habit and develops a small dark red head. It succeeds best if sown in the spring. *Dark Red Niggerhead* is also a medium-sized, dark red and compact-headed variety. *Stockley's Giant Drumhead* is a good strain of the large drumheaded type suitable for a trade requiring large cabbages for pickling. *Lydiate Red Drumhead* is also a good variety of this type.

RAISING THE PLANTS. Plants of red cabbage may be raised from seed sown either at the end of July or in March. In the one instance the crop is treated in the same manner as an ordinary spring cabbage crop and in the other as a summer cabbage crop. The small-headed varieties are the best for spring-sown crops.

CULTIVATION. The general lines of cultivation follow those practised for other cabbage crops. As quality is an important factor in pickling cabbage the use of a complete fertilizer that is relatively fairly high in phosphate should be used.

MARKETING. Spring-sown crops are normally marketed during the period September to December, while autumn-sown crops are usually ready for cutting during June, July and August. Red cabbage takes rather longer to develop than the green varieties.

Sprouting Broccoli. The demand for this, the real broccoli, has developed in recent years, and this vegetable now ranks as one of the brassica crops grown for market.

Varieties. Both the *White Sprouting* and the *Purple Sprouting* varieties are grown, but the latter seems to command the readier sale. Both usually mature in March and must be marketed without delay once ready for cutting. The excellent *Green Sprouting*, or *Calabresse*, popular in Italy and the U.S.A., should be grown more in this country. It is sown earlier than the other types and produces a crop the same season.

CULTIVATION. Plants of *White* and *Purple Sprouting* broccoli are raised from seed sown at the same time as the other types of broccoli, usually early in April. The plants require a long period of growth and should be grown on fairly rich soil. They are usually set out in the field during June, and plenty of space

should be allowed for development—either 2 ft. 6 in. or 3 ft. square. The *Green Sprouting* is sown in March and transplanted in April or early May.

MARKETING. The crop is marketed as soon as the flower buds show, the plants being cut over several times as the shoots develop. The crate makes the most suitable package as damage is thereby avoided, but bags are often used.

Growing Seed of the Cabbage Crops. The cabbage, cauliflower, brussels sprout, broccoli, kohl rabi and some of the kales are all varieties or relations of the original wild cabbage, *Brassica oleracea*, a species indigenous to Europe. The fact that all these forms are closely related, having the same chromosome number, must be borne in mind when seed of any particular crop is to be saved, as unless properly isolated, intercrossing, with a resultant degeneration of the stock, will take place. In general, no other related seed crop should be allowed within a radius of at least one mile from the crop being grown, and the more widely separated each crop is the better are the chances of obtaining a yield of seed free from contamination. Bees and other insects are active instruments of cross-pollination.

Cabbage is usually specially grown for seed in two ways. The plants are put out in the late summer from 18-24 in. apart in the rows, according to the variety, with the rows 3 ft. apart. When the plants form hearts they are cut across both ways with a sharp knife to allow the stem to break through. Tight compact heads will not freely run up to seed. Such crops tend to harvest late, and some growers prefer to take seed from stump plants, that is, plants that had their hearts cut out in the year following planting and have made fresh growths that flower the following May and thus ensure a good harvest. This method takes up to 20 months.

Savoy Cabbages are grown for seed as a normal crop and left through the winter, or are planted late so that hearts do not form before winter. Some heads may be lost if the weather is severe. All "off-type" plants should be pulled out as soon as detected. Often only 50 per cent of the crop is left after the

winter is over, and it is customary to lift and plant back a portion of the crop in order to make a full "plant" on the land. The heads must be cut across in the manner similar to cabbage to enable the seed stem to run up.

Cauliflower. It is difficult to save seed of cauliflowers in northern latitudes, because the plants cannot over-winter in the open, and the summer is too short to secure good seed from spring-planted crops. Seed of the earlier, Dutch and French, types of cauliflower can, however, be secured if some care is taken, but seed of the Italian types is usually mported from countries where it can be successfuly grown, such as Spain and Italy.

To obtain crops of cauliflower seed the plants should be raised in the autumn in cold frames and be planted out 3 ft. apart each way during the following March in the same manner as crops of cauliflower grown for market. The plants will usually run to seed by August, and if the weather is fine and dry the crop of seed can be safely harvested.

Broccoli presents very little difficulty, as plants grown in the usual way can be left to run to seed in the second year of growth. Careful rogueing is essential for both broccoli and cauliflower, and only selected heads should be grown on for seed. If necessary the plants can be lifted and planted up to cover the ground after selection, but it is best not to disturb them.

Brussels Sprouts. This crop is grown for seed on lines similar to those for the market crop. The crop should be rigidly rogued and all "off-type" plants discarded. It is customary, when small lots of seed are grown, to lift the selected plants in March and plant them out 3 ft. square. Larger areas are left to run to seed where the plants were grown.

As seed crops form the principal method of "over-wintering" for the cabbage aphis, the plants should be inspected for the presence of both adult insects and eggs. If present spraying ot dusting with nicotine or derris preparations should be carried out at intervals during May and June to keep the pest in check.

Seed crops of *Brassica* are cut and stacked after the manner of mustard. The seed may be threshed out with a machine or

flailed out by hand; it should not be bagged up until perfectly dry, as damp seed develops mould.

The yields of seed vary considerably; cabbage, savoy and brussels sprouts may give from 5 to 7 cwt. per acre, while the heading broccoli and cauliflowers yield low, from 1 to 2 cwt. per acre being average crops. The kales give about 7 cwt. per acre.

CHAPTER SIX

Leguminous Crops

The leguminous vegetable crops grown for market comprise green peas and beans of several types. There are two classes of beans : the Broad Beans, which are shelled in the green condition like green peas, and the Runner and Kidney Beans, the young green pods of which are sliced for cooking. The latter are sometimes called ''string or snap beans''. Collectively these crop rank next in importance to the Brassica crops, and as the third important group of vegetables grown for human food. Peas are grown both for drying and canning on a large scale. Dried beans are not produced to any large extent in Britain as the climate is rather unsuitable for harvesting the crop. The stringless type of Kidney Bean is grown for canning in the green condition.

Peas. The importance of the pea crop is enhanced by the fact that during the last twenty years the canning industry has also taken an increasing quantity of both green and dried peas for processing, and many growers now produce crops both for marketing green and for canning and drying.

VARIETIES. The markets prefer the larger, dark-green podded peas, but smaller podded varieties are used for early picking. For early crops varieties of the hardier, rounded-seeded group are mostly grown, but for second-early and the main and late crops wrinkled-seeded varieties are used. For maincrops the large, dark-podded varieties, such as Onward and Alderman, are favoured. Special varieties are chosen for canning and drying.

It is difficult to give a selection of peas, for there are many varieties, some of which are nore favoured in certain districts

than in others. The following list can, however, be relied on to supply all the needs of the markets and give a succession of crops throughout the season. With peas, as with other vegetables, it is very important to secure seed of good, carefully-selected strains. Badly saved stocks often contain a high percentage of rogues.

A. Early Round-seeded Varieties.

Early Bird ...	... 3 ft.	British Lion ...	... 3 ft.
The Clucas ...	... 3 ft.	Laxton's Superb	... 2 ft.
Foremost (Sutton)	... 3 ft.	The Pilot ...	3 ft.
Forerunner ...	... 3 ft.	Meteor ...	... 1 ft.

B. Early Wrinkled-seeded Varieties.

Kelvedon Wonder	... 1½ ft.	Little Marvel	... 1½ ft.
Laxton's Progress	... 1½ ft.	Thomas Laxton	... 3 ft.
Gradus ...	... 3 ft.	Lancashire Lad	... 2 ft.

C. Second-early Wrinkled-seeded Varieties.

Onward ...	... 2½ ft.	Dwarf Defiance	... 2½ ft.
Duplex ...	... 2½ ft.	The Lincoln ...	... 2 ft.

D. Maincrop Wrinkled-seeded Varieties.

Admiral Beatty	... 4 ft.	Prince Edward	... 5 ft.
Alderman ...	... 5 ft.	Standard ...	... 5 ft.
Gladstone ...	... 3½ ft.	Stratagem ...	... 2 ft.

Lincoln, Onward and Alderman are probably the three maincrop varieties of market peas grown most extensively by growers to-day. *The Clucas*, *Forerunner* and *Foremost* are good for first early crops sown in February. *Thomas Laxton* and *Onward* are regarded as most suitable for quick-freezing.

Climatic Requirements. Peas prefer cool, moist conditions and do better in a mild, showery summer than in a dry one. At the same time they do not like cold nights. A cool equable temperature is the best.

Soils. A most important point in choosing land for peas is the question of drainage, for the crop does not thrive on badly-drained, wet soils. Well-drained land allows of early sowing and the early maturing of the crop. As a general rule the lighter soils are satisfactory for early crops, but the stronger loams, possessing a higher clay fraction, are the best soils for maincrop peas. Soils containing high proportions of clay or silt are, however, apt to "pan" down after sowing, and the crust

so formed tends to reduce the plant and may even promote losses from disease. Peas delight in a tilthy surface at all times.

LAND PREPARATION. Peas do best on well settled land, so all land for the crop should be ploughed as early as possible. It should be well worked during dry periods. Land for early crops should be autumn ploughed, any that are intended for March and April sowings should be ploughed during the winter. The cultivators and harrows should be used on all favourable occasions to get the land into condition for sowing. A little extra work with the harrows before drilling is usually well repaid by the crop. A crumbly type of tilth is better than a finely divided surface soil, especially on the silty loams that tend to run together and form a crust after rain if left too fine.

MANURING. Peas are seldom grown on manure, as this not only promotes excessive "straw" but allows the land to lie hollow. Manuring also encourages diseases. This crop does best if it follows a cultivated crop that was well manured, such as potatoes, and is given a moderate application of a fertilizer containing a good proportion of phosphoric acid. On many types of soils superphosphate alone is the most satisfactory fertilizer, but the use of a little nitrogen is recommended on the lighter types of soil. A good fertilizer for green peas on light loams should contain from 1-2 per cent of nitrogen, from 8-12 per cent of soluble phosphoric acid, and from 4 to 6 per cent potash. Amounts ranging from 300-500 lb. per acre of this type of fertilizer may be used according to the character of the land. Less potash is required on heavier loams; on such soils phosphate alone is often sufficient before sowing. Basic slag is a good phosphate fertilizer for peas on heavy soils. If superphosphate only is used, amounts ranging from 300-400 lb. per acre should be sufficient for normal conditions. The land for peas should be well supplied with lime; if deficient, it will pay to give an application when the land is being cultivated. Shortage of lime and bad drainage are often directly responsible for the failure of pea crops. A small amount of nitrogenous fertilizer (100-200 lb. per acre), used as a top dressing when the plants are 6 in. high is often beneficial.

Pea seed may be subject to injury if brought into direct contact with fertilizers; it is thus safer to apply the fertilizer

a week or so before drilling, and not feed it through the drill with the seed, as is done with combine drills.

Lastly, peas should not be grown on the same land more frequently than once in four years. In many districts an interval of six years is preferred. Several serious pests and diseases of peas live on in the soil, and a wide crop rotation tends to reduce these.

Seed Sowing. Peas can easily be drilled with the ordinary grain drills. Distances between the rows vary according to the variety. Tall, strong-growing varieties require more space than the dwarf kinds. Distances apart range from 12-24 in; 14 in. to 15 in. is a good distance for 3ft. varieties. The amount of seed sown per acre also depends upon circumstances. It is usual to sow more for early crops to allow for losses; thus, up to 4 bus. of seed are often sown in January and February, and from 2-3 bus. in March and April. One bushel of wrinkled pea seed weighs approximately 56 lb.; round-seeded varieties weigh 60 lb. per bushel.

Early sowing of early varieties is desirable. Where conditions are favourable a few growers sow earlies in the autumn—October-November, while others sow from mid-January onwards through February, according to the district and land. As a rule peas drilled in January or early February are as early as, or very little behind, those sown in the autumn. Autumn-sown crops often go off in severe weather, leaving the work to be done again. Second early peas are usually sown in March, and main crops during April and early May. Early sowing of all classes of pea crops is desirable in order that the maximum growth of plants may be obtained before the warmer weather sets in. Peas do best in cool, showery weather; hot,dry weather usually brings attacks of thrips and aphides, which destroy the growing shoots. On the other hand, continually wet weather is equally harmful, as the pods fail to develop and the straw becomes too lush.

Cultivation. Peas are a land-fouling crop, and it is imperative that the land should be kept clean by frequent horse-hoeing, and by hand-hoeing later on when the haulm is too high to permit the machine to pass down the rows. Thistles and charlock that may appear in the lines of plants should be hand-pulled.

FIG. 32.—Seedlings are raised under double Dutch lights.

CELERY GROWING FOR MARKET.

Celery growers rely on specialist plant raisers for supplies of plants.

FIG. 33.—Pricking out the seedlings.

FIG. 34.—A unit of frames for raising plants on an Essex farm.

PLANT RAISING IS AN IMPORTANT SECTION OF MODERN VEGETABLE PRODUCTION FOR MARKET.

FIG. 35.—Raising early cauliflower plants in frames.

FIG. 36.—Outdoor tomato cultivation. Transplanting by machine, showing how the plants are handled.

Photo by courtesy of Transplanters (Robot) Ltd.

FIG. 37.—Outdoor tomato cultivation. General view of planted field in crop.

Photo by courtesy of Geo. Monro Ltd

FIG. 38.—Mushroom Growing for Market : Outdoor beds covered with straw and hessian for protection.

THE PRODUCTION OF EARLY CROPS.

FIG. 39.—Mushroom Growing for Market : Indoor beds in full production.

Photo by courtesy of Geo. Monro Ltd

PICKING AND MARKETING. Market peas are usually cleared at one picking by gangs of pea-pickers who pull the plants and remove all pods as they go along. It is difficult to attempt systematic packing with peas, but it pays to make a good sample. To this end, all over-mature, "corny", pods and "flats" (immature pods) should be excluded. The markets will usually return better prices for a good sample of green peas. Peas are marketed in "half-bags" containing 40 lb., but wooden crates are sometimes used with advantage for early crops and special samples. Crops of early peas may range from 100 to 200 half-bags per acre, while yields of 200 half-bags per acre are average crops of main-crop peas.

Peas for Drying. The very large trade in dried peas for human food, estimated at over 60,000 tons, is maintained both by home-grown and imported supplies. The climates of Middle Europe and New Zealand, main sources of imported supplies, favour the production of a well-harvested sample; moreover, the bines dry quicker and more uniformly, so facilitating the use of pick-up "headers" for harvesting of the crops. However, a large acreage is annually grown in England—principally in the counties of Lincolnshire, Cambridgeshire and Suffolk.

VARIETIES. The trade is mainly concerned with the smooth- or dimpled-seeded types, notably the so-called "marrowfat" type, which is generally the variety *Harrison's Glory*, a hardy, smooth, blue pea, very suitable for field cultivation. The small type of pea known as *Small Blues* or *Lincoln Blues* (a form of the old *Prussian Blue* and which should not be confused with *The Lincoln*) is also somewhat extensively grown but mainly for canning as it is a good pea for processing. Between these are *Unica* and *Mansholt* which are shorter in straw with peas of medium size. A new form called *Mammoth Blue* has been obtained in New Zealand by crossing *Prussian Blue* with *Harrison's Glory*. Some of the wrinkled seeded varieties, such as *Onward*, *English Wonder* and *Witham Wonder*, are also harvested as dried crops and sold for various purposes.

PREPARATION OF LAND. Treated as a field crop, peas for harvesting should be sown on well-prepared land, preferably autumn-ploughed. A good "cloddy" seed-bed is prepared

in early spring without disturbing the bottom soil or loosening up the land unduly. This method of seed-bed preparation is important because soil that is too fine on the surface will run together and give a surface crust that hampers seedling emergence and favours drilling too deeply, which does not give the best results. The seed-bed tillage should, therefore, be done as far as possible with harrows.

Sowing of Seed. Early drilling which, however, must depend on the state of the season, type and condition of the land,and the variety, is favoured, as advantage is secured from soil moisture, early ripening and an escape from attacks of aphides, which often damage later-sown crops. From early March to late April is the best period for drilling. Row widths of 7½ in., 15 in. or 21 in., are used where the ordinary Suffolk cereal drill is used without shifting the coulters, and from 2 to 4 bushels of seed are sown to these row widths. Other widths used are 9 in. and 12 in., obtained by moving the coulters. The wider row widths permit of more effective and continuous inter-row cultivation which is beneficial and assists in controlling weeds that often tend to smother the crop later in the season. Germination usually takes from 6 to 10 days according to the season.

Fertilizers. Except on the richer types of land the use of a complete fertilizer, approximating the 1-2-1½ ratio, in the seed-bed is usually profitable. The crop is sometimes drilled with 2 to 3 cwt. of superphosphate per acre in the seed-bed, which will not harm the seed and definitely assists germination and the seedlings. Applying the fertilizer by means of a combine drill is, however, not recommended. Land used for this crop should be well supplied with lime, for although peas tolerate slight soil acidity, lime is necessary for several reasons.

Harrowing. When the plants are through the soil and from 2-3 in. high the land should be harrowed. Although it may sometimes appear to damage the crop, harrowing has been proved to be well worth while. Special light pea harrows are generally used. Harrowing breaks the soil's surface crust, destroys weed seedlings and lets in air. Apropos of harrowing, the experienced pea grower's maxim is worth noting, "go for your life and don't look back."

ROW-CROP CULTIVATION. Inter-row cultivation with hoes until crop growth becomes an impediment will maintain a control of weed growth. Some hand work may be necessary to clean close to the rows. Docks, goosefoot and thistles should be pulled out.

HARVESTING. Most crops are cut either with a mower or a special pea-cutting machine, and the cut vines are laid up in swathes or windrows to dry for a period of 10 days or so. In wet seasons the use of tripods and four-poles are an aid and assist in preventing crop loss through damage and the production of discoloured low-grade samples. Tripod harvesting is a good practice whatever the season, though it calls for more labour, as the crop dries more satisfactorily, giving a cleaner, brighter sample of grain. Under very favourable conditions the crop may be threshed out of the swathes with a pick-up header harvester, the sacks of peas being taken direct to the dryer, thence to the dresser and store. Generally in England, however, the crop after drying in the swathes is swept into cocks for further drying, then stacked for a period in carefully-built outside stacks or under Dutch barns, and is later threshed out from the stack. Some growers prefer to stack the peas for a period, claiming that there is less loss from splitting and skin cracking. There is no doubt, however, that under the right conditions, harvesters can be safely used for harvesting peas from the swathes, thereby saving the labour and expense of stacking. When using pick-up headers the swathes should be on the light side; poor threshing will result from overloading the machine.

THRESHING FROM THE STACK. To avoid splitting and other damage the drum of the machine should be carefully adjusted to give a speed of about 600 r.p.m. or slower; the slower the speed the better. It is also advisable to remove alternate beaters on the drum. This slower drum speed should be obtained without slowing up the rest of the mechanism, *i.e.* by means of the driving pulleys, otherwise the air blast and riddles that screen and dress the peas as they go through will not operate so effectively. Other adjustments, usually known to skilful machine attendants, are also needed when threshing peas. If a clean sample is not obtained from the thresher the adjustments and riddles are not correct. With the dried pea crop it is the

close attention to all details of harvesting, threshing and cleaning that makes for the production of a good clean sample that will realize a satisfactory price.

Peas for Canning. During the last 20 years the canning of fresh green peas has developed extensively, and thousands of acres are now annually grown especially for this purpose, mostly, however, on the basis of contracts or other agreement with the factories that take the crops.

TYPE OF PEA USED. Not all types of peas are suitable for canning in the fresh condition. From the processing point of view the ideal canning pea should, after processing, be of a good green colour, sweet and of attractive flavour (not mealy or starchy), retain shape without splitting and leave the liquid in the cans clear and not cloudy or discoloured. From the grower's point of view the type grown should be of good constitution, of quick growth, capable of maturing the majority of pods about the same time and of being handled successfully by the vining machine.

Not many varieties have been found capable of meeting all these requirements, most of the well-known market green peas being unsuitable, mainly because they crop irregularly and become starchy quickly.

Alaska Type. The varieties of this early white, round-seeded type known as *Earliest of All* (Laxton), *Alaska*, *Express Alaska*, *Prince Albert*, *Eclipse*, are, because of their hardiness, grown for early crops, but their cropping powers are rather below average.

The Lincoln Type. Of the wrinkled-seeded class this type has been found to be a useful canning pea from all points of view. The varieties *The Lincoln*, *Charles I*, *Onward* and *Delicatesse*, are suitable for maincrops of canning peas. The *Delicatesse* is the *Petit Pois* of the French canning industry, and the *Delicates* of the Dutch.

Admiral Type. This wrinkled-seeded type is also much grown for maincrops of canning peas being extensively grown in the U.S.A. and Canada for this purpose. Varieties are known as the *Admirals* (of which there are both green and white-seeded strains). *Prince of Wales* and *Thomas Laxton*, rather distinct

types of pea, are used for canning on occasion, and *Canners' Perfection*, as its name implies, is a maincrop variety of established value for canning. *Surprise*, one of the earliest wrinkled-seeded peas, is also grown for canning both in the U.S.A. and in Britain.

There are a few other varieties known to be suitable for canning. As a rule, the canning factory indicates the variety desired and not infrequently supplies the seed and arranges the sowing date to ensure that the crop is correctly timed for their purpose.

Preparation of Land and Manuring. As it is customary to grow the peas on land that was well manured for the preceding crop (*e.g.* potatoes), available nitrogen is usually sufficient. A phosphate fertilizer (200-300 lb. of superphosphate per acre) should, however, be applied before sowing. The addition of some potash is beneficial both to growth and quality of the crop; 50 lb. of muriate per acre is sufficient. The land is prepared in the manner indicated for other pea crops. Peas should always be sown on a firm, but tilthy seed-bed.

Seed and Sowing. When grown under contract the factories usually give dates to their growers for sowings to be made to provide a succession of crops. Canning peas are normally sown from about mid-March, throughout April into early May, beginning with the *Alaska* type. *The Lincoln* is a very reliable variety for successional sowing—three batches can usually be sown at 10-day intervals with good results. *Prince of Wales* and *Onward* are good varieties for late sowing.

From 3 to 3½ bushels of seed per acre are usually sown, the rows being 12, 15 or 18 in. apart, though some growers sow at 7½ in. It is considered that with canning peas there is some gain from the use of closer rows, as the crop stands up better and is thus easier to mow. On the other hand, it is considered that stronger and more prolific growth comes from the wider-spaced rows.

Handling the Crop. Crops of peas for canning are mown and either carted to the factory for threshing or are threshed on the farm. Special types of threshing machines called "viners", which extract the green peas from the pods without damage, are used. Crops of larger-podded varieties are occasionally

picked by hand and the pods are taken to the factory for shelling by machinery.

Yields vary according to the season. Under average conditions *Alaska* types can be expected to yield up to 20 cwt. of threshed peas per acre, and *The Lincoln* type from 20 to 25 cwt. Higher yields are, of course, recorded. Very careful judgment is required to secure the crops at the most suitable stage for canning; in this the opinion of the factory's field representative is usually acted upon.

Green pea haulm after threshing is valuable for stock feeding, either in the fresh state or dried as hay. It also makes a useful silage. It should never be wasted, for if not required for feeding it can be made into useful compost for application to the land.

Seed Growing. The garden or green pea has been cultivated by man since ancient times. In fact its wild prototype is not known. It may have arisen originally as a chance variation. Nothing definite is known.

Genetically, the garden peas are rather unstable, and constant care must be exercised to preserve varieties true to type. Off-type plants constantly appear in the stocks. Seed should be grown from good mother stocks that were carefully and thoroughly rogued at least twice during the growing season, and usually the second crop is rogued again. Roguing is best done during the flowering season or later. Although naturally self-pollinating, there is a slight risk from crossing with other varieties if not isolated to some extent, and crops of seed peas of different varieties should not adjoin each other.

Seed crops are cut just before the haulm becomes dead ripe, and are left to cure in the field. The crop should then be stacked and threshed out later with a drum machine, but the drum should be adjusted to avoid splitting the peas. After threshing, the seed is cleaned and hand-picked to remove discoloured and weevil-damaged peas. Average yields are from 8 to 10 cwt. per acre.

Single plant selection forms a useful method of securing improved strains of a variety, but only skilled plant breeders are able to undertake the hybridizing of peas to obtain new varieties.

Beware of Seed-borne Diseases. Growers who save seed of peas and by careful selection bring about an improvement in the strain, should make sure that their plants are free from the fungi that cause spotting. The two most concerned are *Ascochyta pisi* and *Mycosphaerella pinodes*, the first causing pale-brown spots and the second purplish-brown spots one leaves and pods. If affected plants are not pulled up and destroyed the trouble will appear again the following year, for the seed is nearly always affected before harvest. Seed suspected of being infected may be dressed with 2 oz. per bushel of an organo-mercurial dry seed dressing (see p. 99). These dressings not only check the diseases but by protecting the seed from soils organisms ensure a stronger and more even germination of the seed.

Runner and French Beans. Runner beans include the Scarlet Runner and other varieties of *Phaseolus multiflorus*, a class of beans that is very popular with the British public, and is always in demand.

The Kidney, the so-called French or Bush bean, is a milder flavoured type of bean of another species, *Phaseolus vulgaris*, and is also a popular green bean, particularly in some markets. In this connexion it is a noteworthy fact that some markets prefer runner beans, while others prefer French beans. The following list, which is not complete, provides information on this point.

Runner Beans preferred.	*French Beans preferred.*	
London (after mid-July)	London (before mid-July).	
Birmingham and Midlands	Liverpool	Glasgow
South Wales	Southport	Edinburgh
South Coast towns	Blackpool	East Coast towns
	Sheffield	North Wales
	Bradford	

This preference of the northern markets for French beans is of special interest and should be borne in mind by growers.

Runner Beans. Runner beans succeed best on light loamy soils that warm up quickly in the spring. Thus large acreages are grown in Bedfordshire, Suffolk and Essex, where such soils are found.

VARIETIES. The most popular varieties with market growers are *Scarlet Emperor*, *Prizewinner*, *Best of All*, *White Prize-*

winner, *Painted Lady*, *The Marvel* and *Princeps* can be recommended. The last-named is an earlier and dwarfer type of scarlet runner that, on account of its prolific habit, is very useful for market growers who desire early crops. *The Marvel* is a very prolific form of *Painted Lady*.

LAND PREPARATION AND MANURING. Beans, like peas, prefer well settled land, so that all ploughing should be done some months ahead of the crop. Either autumn or early spring ploughing gives the best results.

Stable or farmyard manure is very seldom applied to the land for beans. Runner beans should crop over a period of two months at least, and organic substances such as hoof and horn meal, in addition to the phosphate and potash advised for peas, will assist in maintaining the plants in a productive condition. A good manurial treatment for beans would consist of from 800 to 1,000 lb. of hoof and horn meal, 400 lb. of superphosphate and 100 lb. of either sulphate or muriate of potash per acre. Nitro-chalk at the rate of from 100-150 lb. per acre provides an excellent stimulant if applied as a hoed-in top dressing when the plants throw their first running shoots.

SEED AND SOWING. Runner beans may be sown by hand in shallow drills, 3 to 4 in. deep, which are ploughed out with a special attachments fixed on a plough or horse hoe, usually the latter, but bean planting machines are also available. Runner beans should be sown during the first fortnight of May, but later sowings are advisable where late frosts are experienced. The slightest frost kills or badly damages the plants.

The rows are usually spaced 3 ft. apart for pinched plants, and the seeds dropped about 6 to 9 in. apart. The drills are then covered in, and a roller is sent over the land to consolidate it. About 1 bushel of seed is required to plant an acre of Runner beans. Early crops are sometimes secured by sowing seed under glass in small pots and putting out the plants in early May in the south or rather later in the north.

Some growers leave all the plants that come up, while others thin them out to about 12 or 18 in. apart. Thinned out plants develop to a larger size and crop better.

METHODS OF TRAINING THE CROP. The common practice with market crops of Runner beans is to pinch out the shoots

at weekly intervals, and so maintain the plants in a bushy condition. The best crops of beans, however, are produced on plants that are allowed to climb, and many growers now have a proportion of their crop either staked or strung. The string, which should be stout, is supported on a framework of posts and wire well secured against the effect of strong winds. When crops of beans are grown on stakes or string, the rows should be 5 ft. apart, to allow a free passage way. While plants grown in this way produce by far the best crops of beans, the installation of posts, wire and strings is an expensive item. If stakes can be obtained cheaply or can be cut on the farm, it makes a considerable difference in the cost. The wire will last several years, but the string must be renewed each season.

CULTIVATION. The land between the rows of beans should be frequently cultivated to keep down weeds and aerate the soil. Runner beans thrive best under warm, moist weather conditions, and the plants make little growth in cold weather. The dropping of flowers is usually due to the effect on the plants of either cold nights or dry soil.

MARKETING THE CROP. Runner beans are usually marketed in half-bags or wicker pots holding 40 lb., but for high grade produce progressive growers are now using light wooden crates lined with paper. The crop should be picked over three times a week, and even if the beans are not required they should be picked regularly, otherwise the plants will go out of bearing.

SEED GROWING. Runner bean seed is usually saved after the manner of peas. The plants are never pinched but allowed to ramble and are either cut or pulled when the majority of the pods are mature but not fully ripe. After curing in the field the crop may be stacked to avoid discoloration of the seed, a difficult matter if the weather during harvest should turn wet. Much Runner bean seed is grown in California and in Central Europe, where the climate is more dependable at harvest time. An average yield is 12 cwt. per acre.

Kidney or French Beans. For market only the green-podded varieties of Kidney beans should be grown; the yellow-podded, so-called "butter beans" are seldom, if ever, called for. Again, it is only varieties of the stringy class that are grown for market

at present, as although the canner requires the stringless varieties for canning, they are not yet in demand on the markets. This is probably due to the fact that the pods of stringless varieties are normally neither so large nor so well shaped as those of the stringy class, although the former are usually better flavoured. With this vegetable, however, as with others, the grower has to supply what the public wants. It should, however, be said that some of the newer varieties of Kidney bean are almost stringless. While there are climbing varieties of this bean it is seldom that they are grown in open land for market in Britain—the dwarf varieties being universally favoured.

Varieties. Early Warwick or *Early Prolific*, *Negro Early Longpod* and *Clucas's Black Wonder* are good varieties for early cropping. *Canadian Wonder*, *Masterpiece*, *Black Prince*, *Superlative* and *Negro Mammoth* or *Negro Monster* are all reliable varieties for main crops. All produce long, straight, smooth, flatish pods, which is the type of bean the market requires.

The wax-pod or yellow-podded varieties are little grown for market.

Soil. Kidney beans thrive best on light, loamy soils, but all land for the crop should be firm, even firmer than for runner beans. The surface soil should be worked into a good tilth before the seed is sown.

Manuring. A moderate application of a phosphate-potash fertilizer usually suffices for this bean crop. From 300 to 500 lb. per acre of 0-12-6 or a 0-8-4 mixture should be well worked in a week before the seed is sown. Nitrogen should be added to the mixture only when the land is on the poor side, and to the extent of not more than 20 lb. per acre. Phosphate is the chief requirement of this crop under average conditions. Good crops of beans may also be secured by using one of the phosphatic guanos, such as Peruvian, at the rate of 500 lb. per acre, or thereabouts.

Seed and Sowing, Kidney beans require a warm soil and high temperature, hence early sowing of the crop out of doors is of no avail. As a rule sowings should commence from the first week of May according to district, and continue throughout

that month and during June to provide successive croppings. Crops may also be obtained from seed sown in July in favourable districts.

The seed should be sown in rows from 18—24 in. apart, according to the variety (the early varieties making less growth), and about 1 bushel of seed should be allowed per acre. Much of this crop is usually planted by hand, with dibbers, as thereby the solidity of the soil, an essential feature, is not disturbed. The seed may also be sown in drills like Runner beans, and very large acreages may be drilled with an ordinary grain drill. There are also bean planters of the type much used in America. Shallow planting is important with this crop; the seed should never be deeper than 2 in. as a general rule, although up to 3 in. may be allowed on very light soils. The seed should be dropped from 4-6 in. apart, and the plants should be thinned out if required.

Overcrowded rows of plants are undesirable, as the cropping is impaired and diseases are encouraged. Many growers prefer to have the rows of plants 28 in. apart on this account.

Cultivation. Frequent cultivation of the land between the rows is essential. Cultivation should, however, be shallow, and the work should not be done when the plants are wet with dew or rain, as this helps to spread the two serious diseases of beans, Halo Blight and Anthracnose.

Picking and Marketing. The plants should be picked over three times a week when they have reached a full bearing condition, so that only young tender beans are marketed. Although they are used to some extent, bags are not such a suitable market package for Kidney beans as wooden boxes and crates or wicker baskets. During spells of hot weather, it will be well worth while to pick the beans in the early morning and keep them in a cool store until dispatch. It is very important to keep perishable produce such as green beans and peas as cool as possible. Very early crops of Kidney beans often make very good prices, and for such crops the 12-lb. chip basket is generally used.

Early Crops. Very early crops of Kidney beans are obtained by forcing under glass (see Chapter XII, Forced Crops). Early crops for picking out of doors are also obtained in favourable

districts by sowing the seed in cold frames or under Dutch lights in early April after the lettuce crop is finished. The continuous cloche is also a useful device for protecting early-sown crops in the open field, and the Evesham hand-light has also been successfully used for early Kidney beans.

Seed Growing. Kidney bean seed is saved in the same manner as advised for peas and Runner beans. Care should be taken to rogue out all off-type and diseased plants, and crops showing a substantial proportion of virus (mosaic) should not be saved for seed.

Green Beans for Canning. As with peas, fresh beans for canning are usually grown for the factories on a contract basis, the factory often supplying the seed.

The bean universally used for canning is the French or Kidney bean, but only certain types are suitable. A fresh bean for canning should be relatively stringless and fibreless, of good shape and colour and be capable of maintaining its colour after processing.

Types Grown. The European varieties are not so suitable for canning. Specially suitable varieties are obtained from North America where the canning of fresh beans has been extensively practised. Both green-and yellow-podded varieties are used, those most extensively grown being of the *Green Refugee* and *Golden Refugee* types. *Keeney's Stringless Green Refugee* and *Keeney's Stringless Waxpod* are varieties of these types much grown. Others are *Early Refugee*, *Hodson Wax*, and *Round Yellow Wax*.

Cultivation of the Crop. The beans are grown in the same way as those for market, the plants being picked over at frequent intervals to secure the crop in the best condition for canning. The rows of plants are often wider spaced than customary, so that the pods are less likely to be spotted by disease. A yield of 2 tons per acre is regarded as a good crop.

The Production of Dried Beans. Dried beans, like dried peas, are a source of valuable protein foods, and there is a demand both from canning factories and the ordinary channel of trade. Unfortunately, the climate of Britain given too short

a period for growth, while the late summer conditions are not always of the kind required to harvest this crop successfully. Some attention has, however, been given to the matter of evolving varieties of beans more suited to British climatic conditions.

TYPES. The types of dried bean used for canning is that known in the U.S.A. as the "pea-bean" or "navy bean", a small, rounded, white-seeded type of Kidney bean, *P. vulgaris*. In the trade it is known as the *White Danubian* and *Boston Small Pea-Bean*.

For the ordinary dried bean trade some of the coloured-seeded types, such as the Dutch Brown and the green-seeded *Flageolets* of France are suitable. *Chevrier*, *Wonder of France* and *King of the Greens* are good varieties for producing green haricots, which might well be grown more extensively in Britain.

Examples of European white-seeded varieties that appear to come nearest to the pea-bean used by the canners, are those derived from the French *Common Round White Bean*, of which *Michelet* and *Comtesse de Chambord* seem to be improved forms, and these might be tried experimentally by growers in Britain who are interested. The American varieties seem less suited to our climatic conditions. Plants selected from European varieties have given promising yields at Cambridge, from 500 to 800 beans per plant having been recorded.

When crops of beans are grown for seed they should not be over-manured with nitrogen. They are best grown on land in good condition, to which is applied from 300 to 500 lb. per acre of a potassic-phosphatic fertilizer. If the land is low in nitrogen a nitrogenous fertilizer (not exceeding 100 lb. per acre) should be given as a top dressing while the plants are growing.

HARVESTING THE CROP. To obtain a dark and uniform colour in the green and brown-seeded beans the plants should be pulled when the pods are mature, but before they become yellow, and should be stooked in heaps to dry, protected against the sun.

The plants of white-seeded beans are left until the pods are quite yellow and beginning to dry, but before they split. They are then pulled or cut, left in windrows to complete drying,

then stooked and finally stacked until threshing. Yields are not high, seldom exceeding half a ton per acre, the average being about 8 cwt.

Broad Beans. Broad beans are not quite so popular as either green peas or the Runner and Kidney beans, but there is usually a fair demand from the markets, especially from the Midlands and the north. Broad beans are apt to clash with the peas, and if they can get them, the public prefer the former. In some seasons, however, when peas and spring cabbage are short, broad beans meet a keen demand and make good prices, the earliest crops usually returning the best prices.

Varieties. For autumn sowing : *Seville Long Pod* and *Seville Mammoth Long Pod.* For spring sowing : *Giant or Four-Seeded Windsor,** *Bunyard's Exhibition Long Pod, Johnson's Wonder.*

Soil. Broad beans do best on the heavier types of soil. Strong loams with a fairly high clay fraction and possessing either a clay or marly subsoil are the best. On lighter soils the plants suffer from the effect of dry weather, and yield lighter crops. Crops are earlier, however, on lighter soils.

Preparation of Land. Land for Broad beans should be thoroughly prepared by ploughing deeply well in advance of sowing. The crop responds to a moderate application of yard manure, and up to 10 tons per acre should be ploughed in.

Fertilizers. In addition to dung, an application of phosphate should be given before sowing the seed. This may take the form of from 5-6 cwt. of superphosphate, or a similar amount of a high-grade basic slag. A little potash should be applied, in addition, on lighter soils, but on strong soils may be omitted. Broad beans will not thrive on sour land, and if lime is deficient it should be applied. Good drainage is very essential, especially where the crop has to stand the winter.

Seed and Sowing. As broad beans are difficult to gather if the rows are overcrowded, the best system is to space two rows 12 or 15 in. apart, with alley-ways of 24 or 28 in. between the

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* There are both green- and white-seeded strains of the Giant or Four-Seeded Windsor. Although both are saleable, the public appear to favour white-seeded broad beans.

pairs of rows. The pickers can then pass down the alley-ways without damaging the plants. Also overcrowded plants will not crop so heavily as well-spaced plants. Otherwise the rows should be about 18 in. apart.

The seed is usually either planted by hand with dibbers or dropped, from 4-6 in. apart, in shallow trenches about 4 in. deep, drawn out with a plough. From 2-3 bus. of seed should be allowed per acre.

Autumn-sown crops are usually put in during late October and early November. On an average these crops will stand the winter safely, but they may suffer damage in very severe winters. Spring-sown crops may be put in at any favourable time from the last week of January onwards. Early sowing is very essential, as the crop will do poorly if sown late. Early March is the very latest time for sowing Broad beans. A little time may be made up by soaking the seed for 24 hours before sowing.

Cultivation. Autumn-sown crops require little cultivation, but some growers prefer to draw a little soil up to the plants for protection. The soil should be kept free from weeds and be frequently moved from March onwards, so long as the plants are not subject to damage.

To guard against attacks of "black-fly", the tops of the plants should be removed as soon as the lowest blossoms have set. The tops should be taken right away from the field and be burned or buried.

Picking and Marketing. Broad beans should be gathered while still young, but the pods should be well filled. The crops should be gone over several times, usually once or twice a week, until all the pods are cleared. Crops up to 4 tons per acre have been recorded, but the yield depends very much on the season.

The beans are usually marketed in 40-lb. bags, or in wooden crates holding 20 lb. wicker "pots" and returnable wooden boxes holding 40 lb. are also used in some districts.

Seed Growing. It is not difficult to save seed of Broad beans. The crop, when fully ripe, is cut or pulled, tied in sheaves and stooked until thoroughly dry. It is then stacked under a Dutch barn or in small heaps in the open, suitably covered, until threshing takes place. Smaller quantities may be hand picked, dried on sheets and shelled by hand when perfectly dry.

CHAPTER SEVEN

Root Crops

Rootcrops comprise mainly carrots, parsnips, turnips, beetroot. These, except parsnips, are grown in large quantities for marketing straight from the land as soon as available, and also for storage for winter supplies. The public are particularly fond of carrots and beetroot, the new crops of which become available from June onwards.

Carrots. The carrot is believed to be a native plant of Europe and Asia. Although known to ancient civilization it did not become of importance as a food plant until the 6th century A.D. It is a biennial plant, producing a flowering stem in its second year. There are white, yellow, orange and red-rooted carrots, but only the orange and red varieties (mainly the latter) are used for human food. The shape of the roots shows great variation. Examples are: the globular (French Horn), the short, stump-rooted (Guerande) type, the half-long, cylindrical (Nantes) type, the half-long, stump-rooted (Chantenay) type, the intermediate (James's Scarlet) type, and the long (St. Valery) type.

The carrot is one of the popular root vegetables, and usually sells well, especially when the new young crops commence. It is much favoured in the North and Midlands, and as the colder weather approaches the demand from these areas becomes keener. Early, frame-grown, carrots, mostly produced during April and May, make exceptional prices as a rule. Early outdoor crops can be secured in June in favoured districts, but July is a good month for the early carrot trade. The bulk of the trade in carrots, however, is concerned with the maincrops.

FIG. 40.—The Evesham hand-light.

FIG. 41.—The Dutch light.

Photo by courtesy of Chase Protected Cultivation Ltd.

FIG. 42.—The Continuous Cloche. View of field where strip or panel system of cropping is practised, showing how cloches are handled when moved from one crop to another. Note man and boy taking inside row, followed by another pair taking outside row. Crops : Sweet Corn, interplanted Dwarf Beans, interpanelled with Cucumbers. Photo taken on May 17th.

FIG. 43.—The Continuous Cloche. View of field where strip or panel system of cropping is practised. Crops shown are Sweet Corn intercropped with Dwarf Beans. Cloches are over Cucumbers. Tomatoes in background. Photo taken June 6th.

Photo by courtesy of Chase Protected Cultivation Ltd.

The methods of production vary somewhat according to the district in which the crop is grown.

QUALITY IN CARROTS. It is because of its high content of sugar and carotene that the carrot is such a nutritious root vegetable. As both these constituents are most abundant in the phloem region of the root, carrots with a high percentage of "core", woody tissue, are of lower quality. Again, the proportion of carotene is higher in young carrots, although, of course, the total content increases with maturity. Carotene content is influenced by manuring and its loss during storage is not appreciable.

Sugar content is largely concerned with strain, although weather and manurial conditions influence it also. The quality factor in carrots can be considerably improved by selection, although high sugar content roots selected for seeding often rot in the ground after replanting. Stored carrots lose some amount of sugar content as a result of respiration.

There is no market for fanged or forked carrots, only sound, properly-shaped roots being needed.

The view has long been held that manured land tended to produce fanging in carrots. This seems to be true, but not for the reason generally advanced. An American worker has obtained evidence pointing to the fact that it is the urine in the yard or stable manure that causes fanging. Yard manure free from urine caused no fanging above the normal. The exact nature of the urine substance that caused fanging was not determined. It may be concluded, therefore, that a well-made compost or well-rotted yard or stable manure free from urine may be used on land for carrots without increasing fanging.

Another interesting point concerning the quality factor in carrots is that it is extremely sensitive to soil conditions—so much so that portions of an individual field often produce better quality carrots than the remaining portion. This may be due to the physical condition of the land as much as to other factors, such as availability of plant nutrients, for the carrot is a moisture-loving crop and soil moisture is closely concerned with soil structure.

TYPES. The principle open ground market carrot is the half-long, stump-rooted type which has apparently been developed from the Chantenay variety. Early and improved strains are

known as *New Model* and *Early Market*, many seedsmen now having their own selected strains. This type of carrot develops a smooth, orange-red root with a minimum of core. One of the reasons for this carrot's popularity is that, being almost cylindrical and smooth, it washes easily and keeps its colour after washing. Intermediate types do not pass through the washers easily and are apt to break and suffer other damage.

There is always a demand for young bunched carrots, both early and late sowings being made to obtain these. On light land in favoured districts, e.g. Dorset, sowings are made as late as July to give crops for pulling in the autumn and early winter months. *Early Market* is a good sort for early sowing.

Soils. Good carrots are grown on the black Fen-land soils and also on the sandy soils where there is a fair depth. The best carrot soils are sandy loams. Clay, chalky loams and very gravelly soils are not suitable for the production of good market carrots. The crop does not thrive on acid soils and this fact is often a cause of failure. It is a moisture-loving crop and does best in a cool climate.

Production of the Crop in the Fens. The Fen-land districts give a good deal of attention to the production of early and mid-season crops. Late crops for clamping are also grown. The seed is drilled 8 in. apart, 9 coulters to a 6 ft. drill, from January onwards. The amount of seed used varies according to the season. During the January-February period from 8-10 lb. per acre are sown; in March from 6-8 lb. per acre; and in April from 4-6 lb. per acre. The seed is usually mixed with dry, sifted wood ashes or sand to facilitate a thin and even distribution, as carrot seed is not easy to drill evenly by itself.

Cultivation. All the cleaning of carrot crops in the Fen-land districts is done by hand, the men using short-handled carrot hoes with 7 in. blades. With these tools the men can hoe right up to the row of plants, taking all the weeds, without injuring the seedlings. No thinning is done.

Manuring. On Fen-land soils nitrogen is not usually applied to the carrot crop. On soils that are intensively cropped, however, a little nitrogen may be included with advantage in the fertilizer mixture. The crop usually follows potatoes or celery, both of which are usually well manured. Some growers apply

a fertilizer showing about equal proportions of phosphoric acid and potash, while others prefer to apply more phosphoric acid. As a general recommendation for Fen soils the application of 500 lb. per acre of a 0-12-10 fertilizer should produce satisfactory results; in other words 400 lb. of superphosphate (16 per cent.) and 100 lb. of muriate of potash per acre. The fertilizer should be distributed during the preliminary cultivations, that is, about 10 days before the seed-bed is prepared.

YIELDS. Heavy yields of carrots are obtained on Fen-land soils. In the Chatteris district yields may range from 15 to 30 tons per acre, and even heavier crops have been recorded in favourable seasons.

CARROT CROPS UNDER GENERAL CONDITIONS. As a rule, the best crops of carrots are grown on sandy soils or sandy loams that are non-acid and on which the moisture content can be maintained at a reasonable level. The crop quickly reacts to drought conditions, and shape, colour and texture of the roots are affected by moisture. Hence where possible it pays to irrigate carrots. In Norfolk and Suffolk, where large acreages of carrot are grown on the light soils of these counties, the crop is almost completely mechanized, and yields of from 8 to 12 tons per acre are commonly obtained. The practice of drilling the seed late allows of pre-seeding tillages to destroy germinating weeds and also reduces the risk of damage from carrot fly. Plant thinning is not done, the seed being drilled as thinly as possible and the crop receives only one of two horse or tractor hoeings.

VARIETIES. It is difficult to improve on the *Chantenay* type, of which leading seedsmen stock good strains under various names. The *Intermediate* and *Long* types keep well; *James's Scarlet* and *St. Valery* are good strains.

MANURING. As the carrot crops draw heavily on available potash it is probably unwise to attempt its production without applying a suitable fertilizer. Most authorities agree that potash should predominate in any fertilizer mixture for carrots. Suitable mixtures should show approximately a 5-8-12 analysis (or roughly a 1-2-3 fertilizing ratio), according to the soil.

Thus a useful home-made fertilizer for carrots could be made up as follows :—

100 lb.	Sulphate of Ammonia	N.	20 lb.
200 lb.	Superphosphate (16%)	P_2O_5	32 lb.
100 lb.	Muriate of Potash	K.	48 lb.
Total 400 lb.	Analysis : 5-8-12.	Ratio :	1-2-3.

This fertilizer is suitable for most types of light loams and should be applied at the rate of 400 lb. to 600 lb. per acre, and be well cultivated in a week before drilling the seed. If there is any doubt about the lime content of the land it should be limed at the first cultivation.

Sowing the Seed. As carrot thinning is an almost impossible job on a big-scale production, a thin plant is obtained by drilling from 4 lb. to 5 lb. of seed per acre in rows 15 or 18 in. apart. In some districts drilling on the ridge is practised, the ridges being made 20 to 24 in. apart. To get it through the drill thinly the practice of mixing the seed with about twice the amount of dried wood ashes, sand, or some other material about the same bulk weight as the seed, is adopted. Carrot seed germinates slowly, hence the importance of getting rid of weed seed growth by pre-seeding tillages, for the crop cannot compete with weeds. Some growers mix the seed with damp sand 5 or 6 days before sowing and then sow. This hastens germination.

Control of Weeds. Weed control is the most important factor in carrot growing, and the most vital stage for control is the first few weeks after the seedlings are through. If weeds are allowed to smother the seedlings the crop is likely to be a poor one. While the normal method of controlling weeds is by inter-row cultivation, it is known that an effective control of weeds by means of inter-row kerosene spraying has been obtained in New Zealand. The spraying is done with knapsack sprayers when the seedlings are in the "fern-leaf" stage—1 in. to 1½ in. high—and from 25 to 35 gallons of kerosene are applied per acre. T.V.O. is now being used experimentally in this country.

Marketing. The bulk of the mid-season and late crops of carrots are ploughed-out with a beet plough or dug by hand, washed and marketed in bags. Early in the season some bunch-

ing is done if the market demand is good, but the bulk of the bunched carrots are from specially-grown early crops. Lifting is done by hand and in some districts the men usually dig, top and grade the carrots by the ton. Grading is done for both size and quality, two sizes being made; all split, worm-eaten and badly-shaped roots are reserved for feeding live-stock. The northern markets favour larger carrots than the London markets. The former also take unwashed carrots while London markets usually require them to be washed. All large carrot growers possess mechanical carrot-washers for which an abundance of water is required.

As the winter approaches most growers lift the remaining carrots and clamp them in the field. Others leave the crop in the land and dig supplies as required. Carrots will stand a slight amount of frost, but not severe frost. On the whole it is safer to dig the crop in November and clamp it, for even if it is not damaged by frost when left in the open field, rabbits, hares and mice may gnaw the crowns and spoil the crop. Clamped carrots wash better than those stored under cover in buildings. They will keep in good condition for 5 or 6 months if temperature can be controlled at between 34°F. and 40°F.

Bunching. When carrots are bunched they are usually pulled and bunched by the workers in the field, a temporary table being rigged up for the purpose. The count in bunches of maincrop carrots varies from 4 to 12 according to the district. Six is a good number if the roots are fairly large. The carrots should be graded for both size and quality, poor specimens spoiling the general appearance of the bunches, and they should always be washed clean. The tops are left on or only slightly trimmed.

Wicker hampers and clean wooden crates with the bunches laid in layers, are the best market packages for bunched carrots.

Growing Seed of Carrot. Carrot seed should be grown on loamy soils of good depth. As the carrot is a cross-pollinated plant, a district free from wild and other carrots should be chosen for its production to avoid inter-crossing.

As the carrot is a biennial, the roots must be grown one year and the seed during the next. If the strain of the variety to be grown is good, selection may be ignored and a crop of plants

is usually raised by sowing seed late in the summer, about July-August. Alternatively, stock seed may be used. This sowing will produce small roots (stecklings) that are given some protection, or are lifted and stored, during the winter. The following April the small stored carrots are planted out 12 in. apart in rows 3 ft. apart. The crown of the root should be about even with the top of the soil. As soon as growth commences soot at the rate of 10 cwt. per acre should be broadcast and hoed in. If the land is on the poor side about 6 cwt. per acre of a complete fertilizer, relatively high in phosphorus, should be applied when the land is being cultivated before planting.

The crop should be kept free from weeds and the surface soil loose until the plants cover the land. As soon as a proportion of seed clusters are matured they should be cut by hand, the balance of the crop being cut with the plant when ripe. In this country the seed is best dried off under cover. When thoroughly dried the seed should be threshed out with flails on a canvas sheet, care being taken to avoid breaking the stalks, fragments of which are difficult to remove from the seed. Special machinery is employed for dressing the seed. An average yield of seed is 7 cwt. per acre.

Strains of carrots may be improved by both mass and one-plant selection methods. Only the finest roots are selected from the normal crops for the growing of stock seed. The quality factor may be dealt with by removing small cylindrical sections of cortex and core with a special tool. Roots with a core relatively large to cortex, and those of poor interior colour, should be discarded.

Turnips and Swedes. Turnips are in fairly good demand throughout the year, and in years of scarcity of winter greenstuff the demand for late turnips and swedes often becomes very keen. Swedes are a popular vegetable in the north. The early bunched turnips are, of course, a product of specialist growers who use frames, but bunched turnips from the open ground usually sell fairly well during the summer months. Later on, in the autumn and winter, the trade is chiefly concerned with topped turnips.

The turnips are an important section of the *Brassica* crops. They are a distinct group of plants, all derived from *B. rapa*,

and have 20 chromosomes. The swedes, on the other hand, are also a distinct group, having 38 chromosomes, and are regarded as having originated by a form of hybridization (chromosome doubling) between the cabbage and turnip groups. There are both yellow- and white-fleshed varieties of both turnips and swedes.

VARIETIES. The principal maincrop types of turnips are the *Marble Green Top* and *Green Top Stone*, but for early crops for bunching the all-white turnips are used—e.g. *Early White Milan* and *Improved Early White Stone* (the six-weeks class), which are usually ready 5 or 6 weeks after sowing. The markets always require white-fleshed turnips; the yellow-fleshed type is not in demand.

Most varieties of swedes are suitable for human consumption; the agricultural types are marketed and sell readily. Several improved forms of the garden swede are stocked by seedsmen but from the market grower's point of view the ordinary field varieties serve the purpose.

SOIL. Turnips and swedes do best in fertile, sandy loams well supplied with lime. Tillage before seeding should be of a thorough character, and a complete fertilizer high in phosphate and potash should be applied. An application of 500 lb. per acre of a 4-12-6 fertilizer should be suitable for a crop of turnips of high quality.

SEED AND SOWING. Turnips may be sown at intervals from March onwards, choosing the six-weeks varieties for this purpose. Winter crops of the types should be sown during May and June. The seed should be drilled at the rate of 2-3 lb. per acre in rows 18 in. apart for hand cleaning, or 24 in. apart for mechanical, or horse, cleaning. Early crops are usually pulled and bunched with very little preliminary thinning, but late crops are singled to 6 or 8 in. apart in the rows.

AFTER-CULTIVATION. Turnips require shallow cultivation with hoes to maintain the land free from weeds.

MARKETING. Turnips are usually bunched in odd numbers, such as three, five or seven, according to the time of year. The London markets require rather large bunches, such as nines or even tens. The roots should be clean, and except for very

early produce about half the tops should be removed. Wooden crates and boxes are used as market packages.

Topped turnips should be graded for evenness of size and quality, and should be washed clean. Bags to contain 56 lb. are generally used for packing. Swedes are prepared for market in the same way except that bags containing 1 cwt. are often used.

Turnips are unable to stand very severe frosty weather, and any crops not marketed by November should be pulled and clamped in a well protected site. Swedes stand severe weather very well and need not be clamped.

Saving Turnip Seed. Seed of turnips may be secured either by replanting the stored roots in early spring in rows 3 ft. apart with 12 or 15 in. between each root and leaving the centre bud exposed at the soil surface, or by drilling seed not later than the second week of September, leaving the crop to stand through the winter. The seed crop should be cut by hand and be cured in the field. Small quantities may be flailed out on canvas sheets, but large crops may be threshed. This seed crop requires very careful handling and exact judgment, otherwise there will be much loss of seed through premature shattering of the seed pods. An average yield of seed is about 10 cwt. per acre. There is no necessity to isolate seed crops of turnips and members of the cabbage group or turnips and swedes as each group is genetically different. Crops of forms and varieties *within each group* should, however, be isolated to prevent inter-crossing.

Turnip Tops. These are often in keen demand as a green vegetable especially during periods of scarcity of other crops. For that reason growers of Brassica crops often make a late drilling of turnip seed to secure a plant to stand the winter and yield a crop of tops the following spring.

The seed of a winter variety such as *Marble Green Top* should be sown towards the end of July or early in August. This late sowing may, if the weather be mild, give a supply of small roots for winter pulling if required, but the bulk of the plants will enter the winter period without "bulbing" to any great extent.

The crop may be sown after second early potatoes or peas, and beyond surface cultivation and cleaning no other preparation is required. A liberal amount of seed should be allowed for this crop, 4-6 lb. per acre being advisable.

Turnip-tops are usually cleared at one or two cuttings, the period January to March usually being the marketing season. Only stems that do not show opened flowers should be marketed. As soon as flowers appear cutting should cease. Bags containing a uniform weight, usually 36-40 lb., are used as containers.

Parsnips. This root vegetable is grown fairly extensively for market, although the acreage does not run as high as that of either carrots or turnips. It is very hardy and the roots may be left in the land throughout the severest winter without suffering harm. The flavour of the roots is said to improve by freezing. A slow-growing plant, the parsnip requires a long season of growth. Heavy yields, up to 15 tons per acre, are often obtained under favourable conditions.

Soil. Deep well-drained loams of a cooler nature than the soils usually chosen for carrots are best for parsnips. Manure is often ploughed in for the crop, but in its absence a good application of a complete fertilizer similar to that recommended for turnips should be applied at the rate of 800 lb. per acre.

Varieties. Selected strains of the *Hollow Crown* and *Offenham* types should be grown for market.

Seed and Sowing. Parsnip seed, which germinates very slowly, should be sown in January or February. The seed should be drilled at the rate of from 8 lb. per acre. For hand cleaning the drills are usually from 12-15 in. apart but up to 24 in. should be allowed for mechanical cleaning. The plants should be singled to stand 8 in. apart.

After-Cultivation. Apart from frequent cultivation the parsnip crop requires no further attention. From July onwards the growth of tops usually smothers most of the weeds. Large weeds should be hand pulled.

Marketing. The roots are usually dug as required. The tops are severed and all fangy roots removed. Medium-sized roots are the most suitable for market and they should be clean, well shaped and free from disease. The roots are not usually washed, but if they are very dirty on lifting washing is desirable. The market package is usually the half-cwt. bag, but basket boxes are also used for short range marketing.

Red Beet. Red beet, the market term for table beetroot, meets with a fairly consistent demand throughout the year. Like carrots and turnips, this crop is grown both as a main crop and stored, and as an early crop for bunching. Bunched beetroots are often in keen demand during July and August for salad purposes. Up to 20 tons per acre of maincrop red beet have been grown under favourable conditions.

VARIETIES. For early cropping for bunching the round varieties that develop globular-shaped roots of a good, deep red colour should be grown. *Early Model Red Globe*, *Empire Globe*, *Crosby's Egyptian* and *Detroit Dark Red* are all suitable varieties. *Crosby's Egyptian* is a valuable early variety for the market grower.

For later crops and for storing the long varieties are grown, although of late years round varieties such as the *Detroit* type have also sold well in the autumn months. The principal late beet has always been *Cheltenham Green Top*, but *Covent Garden Dark Red* and *Nutting's Dark Red* are also good varieties of the same type. The oval-shaped type usually known as *Obelisk* or *Nonpareil* is also in demand in some markets.

SOIL. Fertile sandy loams produce the best quality of red beet. The crop is very intolerant of acid soils and lime should be applied if considered necessary for soil improvement. The best quality red-beets are grown on land that is well manured for the previous crop and given a generous application of a complete fertilizer before the seed is sown. From 500-1,000 lb. per acre of a 4-8-6 fertilizer should provide sufficient nutrients for this crop—if well worked into the top soil. If manure is given apply well rotted stable manure at the rate of 10 tons per acre.

Fertilizers for this crop are now augmented by common salt. From America we learn vide *Experiment Station Record*, *Vol.* 95, *No.* 6, that 400 lb. per acre broadcast before sowing increased yield by 6 tons per acre, confirming experimental data obtained at 10 centres in 1945 when 500 lb. per acre were used. The salt may be applied either in the seed-bed before sowing or as a top dressing later. Increases also were obtained when nitrate of soda, also a sodium salt, was used in the basic fertilizer dressing.

SEED AND SOWING. Beetroot is a tender crop and early sowings are speculative. It is a good plan to soak the seed of early crops for 24 hours before sowing. Early crops should be sown in March for pulling in July. From 4-6 lb. of seed per acre should be sown for early crops to allow for losses, while from 3-4 lb. per acre should be sufficient for maincrops. It is as well to leave the plants fairly close together to avoid the production of over-coarse roots. The rows may be from 15-18 in. apart for early crops and from 18-24 in. for maincrops. A first thinning of the seedlings should be carried out when the plants are a few inches high, and a final thinning to 2 or 3 in. apart for early crops and 6 in. apart for maincrops when the plants are well established. The thinnings may sometimes be bunched and sold, if large enough.

MARKETING. For bunching, an even grade of roots from 2½ to 3 in. in diameter is preferable, the number in each bunch varying from 3 to 12 according to the district and market served. It is a mistake to leave round beet in the land once the roots are fully grown, as the quality deteriorates. The crop should be cleared as it matures.

Maincrop red beet is usually sorted into several sizes—small, medium and large, or large, selected, seconds and smalls—according to the class of trade. Large coarse roots are not in demand. This crop is usually clamped until wanted. The clamps should be well protected and not be sited in an exposed position as frost often does damage.

Hampers, returnable boxes and bags are used for marketing red beet. The broccoli and lettuce crates are also used for long-range marketing of high-grade produce, from 18 to 24 bunches of six roots being packed in each container.

SAVING RED BEET SEED. Seed of beetroot may be saved in the same manner as turnips, that is by re-planting selected roots in the spring after all risk of frost has gone. The roots should be set in rows 3 ft. apart with the plants 18 in. apart in the rows. Firm planting is very essential. Large quantities of seed are grown from "stecklings" which are raised in a nursery bed and transplanted in the autumn or spring.

It is a difficult crop to thresh and clean, as the dried stems, which are very brittle, become broken into fragments and mixed with the seed.

Large acreages of seed are obtained by the method of sowing seed late in the season and transplanting the plants in the autumn to stand the winter outside. The crop is often badly damaged in severe winters.

Salsify. This plant is cultivated for the sake of its long, yellowish-white roots, which are stored and used as a winter vegetable, but it has little value as a market crop. It is a hardy biennial of the family *Compositae*. It was not cultivated as a vegetable until about the 15th century, and has gained little popularity, although the roots are high in food value and form a tasty dish when suitably cooked. Salsify is usually to be found in small quantities in the London markets, but meets with only a limited demand. Its cultivation resembles that usually accorded parsnips.

Kohl-Rabi. Kohl-rabi is a vegetable of minor importance. It belongs to the cabbage group of the Brassica crops. It is grown for the swollen stem, which appears, in shape like a turnip, just above the ground, and is cooked like a turnip. Kohl-rabi is grown to a small extent by market gardeners for nearby markets, but not to any extent for long range marketing.

This crop's requirements are similar to those of summer and autumn cabbage. The seed may be drilled and thinned, or the plants may be grown in frames or a seed-bed and transplanted.

The varieties usually grown are *Early White Vienna* and *Early Purple Vienna*.

Kohl-rabi is about as hardy as the turnip and is usually disposed of by the end of the autumn, though it will store quite well. The "roots" are usually bunched like beet and turnips or sold by weight.

Coffee Chicory. The roots of a type of cultivated chicory, when dried, roasted and ground, are used for mixing with coffee, and this preparation finds a ready market in the restaurants, hotels, and amongst the general public, and by the manufacturers of prepared coffee essence. Figures available, those for the year 1930, show that in that year, a total of 70,771 cwt., valued at £35,120, were imported. In addition, 57,196 lb. of roasted or ground chicory, valued at £682, were also imported. Reckoning an average yield of 10 tons per acre, and

taking into consideration the fact that roughly two-thirds of imported chicory is "single dried", it is clear that imports of this commodity were maintaining, approximately, 1,580 acres in cultivation on the Continent. During the last ten years much of this trade has been transferred to the home grower, for it has been found that the growth and general productivity of the crop in the Eastern Counties of England are excellent in every way, and equal in all respects to those obtained on the Continent. Provided adequate attention is given to the technique of drying, the home-grown product is regarded as superior to the imported article and commands very favourable prices in the market.

SOIL. The crop can be grown successfully on a variety of soils, ranging from the light, gravelly land to black, peaty deposits. The roots from the latter soils, although tending to run larger and coarser, with a higher water content, nevertheless yield a product indistinguishable from that grown on other soils. From the standpoint of drying-kiln management, however, it is considered desirable not to mix the crops from various types of soil, and as far as practicable they are kept separate.

As a generalization, it might be said that the ideal land for chicory is a deep, sandy loam with a clay fraction high enough to give it body and render it retentive of moisture. Because of the impediment offered to the harvesting and handling of the crop, a heavy clay soil is not desirable. The Fen-lands provide an excellent type of soil on which to grow the crop, because of their high natural fertility and the facility with which such soils are worked and their crops harvested.

ROTATION. The place of the chicory crop in the rotation appears to be relatively unimportant, for it is possible for it to follow almost any crop or to be followed by any crop. Moreover, with proper attention to the cultivation and manuring of the land, good crops of chicory can successfully be grown for two or three seasons on the same land.

VARIETIES. The large-rooted or *Magdeburg* type of chicory is grown for this purpose. There are two varieties of importance, viz., "*Dunkerque*" and "*Palingkop*". The variety known as "*Smouters*" was formerly very popular on the Continent owing to its heavy-yielding powers, but is of such inferior

quality that the Belgian chicory dryers have made concerted efforts to stop its cultivation. The *Dunkerque* is the variety chiefly grown in England. It forms a shorter but thicker root than *Palingkop* and possesses high quality when dried.

PREPARATION OF THE LAND. The general preparation of the land for chicory is somewhat similar to that for sugar-beet. On some types of soil, notably fen land, it can be grown without organic manure, but it responds to the application of dung, the use of which is imperative on the lighter gravelly or sandy soils. A fair dressing would be 12 loads (15 cwt. loads) of well-rotted manure to the acre. As with sugar-beet, the preparation of a good seed-bed is important, hence the need for ploughing the land in good time, *i.e.* in the late autumn or early winter according to its nature. The ploughing should be done well, and a good working of the soil is very necessary to ensure good results. If a "pan" is present a subsoiler should be used. Good chicory cannot be grown on close-bottomed, shallow-worked land. Care should be taken to select clean land, that is, land free from perennial weeds, such as couch grass, thistles, docks, etc., and this applies particularly when following a cereal crop It is useless to expect chicory to succeed in foul land.

MANURING. At the end of March, the land should be well harrowed and rolled and be worked up into a fine, well-consolidated seed-bed. At the same time, an application of 2 cwt. of superphosphate and 1 cwt. of sulphate or muriate of potash per acre should be broadcast and lightly harrowed in. On the lighter soils the potash should be increased to 1½ cwt. Where no dung was applied to the land these quantities of fertilizers should be increased by 50 per cent and 1½ cwt. of sulphate of ammonia should be added.

SOWING THE SEED. The seed may be sown at any favourable time, i.e. when the surface soil is in a dry, friable condition, from mid-April to mid-May, and must not on any account be sown more than half-an-inch deep, or the germination, which is very rapid, may be seriously retarded or the seed itself destroyed. Very shallow sowing is an important point with this crop and it is a point that should on no account be disregarded. The seed is drilled, the best spacing between the rows being from 12 to 16 in., using from 3 to 4 lb. of seed per acre. After

sowing, the land should be rolled with a light smooth-faced roller, but on heavy land the roller should be used with discrimination to avoid forming a crust. No advantage is to be gained by sowing earlier than the dates mentioned; on the contrary, seed sown earlier tends to produce a high percentage of "bolters," or plants that run to seed in the first year and are useless for the production of roots.

AFTER-CULTIVATION. A most important cultural operation is slingling of the crop, in fact, the success of the crop will largely depend on it. If neglected or badly done the crop will not only contain a large proportion of small roots—which are not required by the drying factory—but the cost of lifting and handling will be correspondingly increased.

When the seedlings are well up, with the third or fourth leaf showing, the land should be horse-hoed to stir the surface soil, destroy weeds and provide aeration. A fortnight to three weeks later the crop should be hand-hoed and singled. The plants are singled by hand, and experience has shown that chicory will be most successful when spaced about 9 in. apart in the rows. It is useless to try to avoid the expense of singling by drilling the seed thinly.

About a fortnight or three weeks after singling the plants will be greatly benefited by an application of a nitrogenous fertilizer. Experience has shown that this is best applied in the form of nitro-chalk at the rate of 1½ cwt. per acre. Hoeing should be continued as required to keep the crop free from weeds.

It is advisable to pull up and remove all "bolters" as soon as they can be detected, as such are useless and only rob the land.

HARVESTING. The crop is ready for harvesting when the roots have reached a size large enough for drying. This will depend on the type and general fertility of the land, cultivation, rainfall, etc., but under favourable conditions harvesting may be commenced from about mid-September onwards. As a rule the factories plan to start drying about the end of September, and continue as long as supplies are available, but the crop is usually all out of the ground by the middle of September. The frosts normally experienced during October or November will not do any material damage to the roots if out of the ground

and stored in heaps, but during spells of severe frost the heaps should be afforded protection by covering with straw or other material.

Much of the crop is lifted by hand with forks, and this is often done as piece work at an agreed rate per acre. For this the worker has to lift the roots, taking care to see that they are removed whole, screw off the tops by hand and pile the roots in heaps convenient for carting. On light soils and on the fen lands crops are now being successfully lifted with sugar-beet lifters, but generally speaking, hand lifting with forks is the preferred practice, because of the importance of guarding against damaging the roots, which must be delivered to the factory in good condition and free from cuts and bruises.

Drying. At the factory the roots are washed clean in a specially-constructed rotary washing machine, and then passed through a slicing machine that cuts them into cube-like pieces. These are then drawn up to the top of the kiln and spread out on the first of a series of drying floors. The heat for drying is obtained from coke ovens at the base of the kiln, the hot air passing through a series of perforated floors to exits at the top of the building. As the drying proceeds each batch is turned over with wooden shovels at intervals of two hours, to prevent scorching, and in turn shovelled down on to the floor below, until at the lowest floor (that nearest the fires) the drying is completed. On an average it requires from 4 to 5 tons of fresh chicory to yield 1 ton of "single dried" chicory. The "single dried" chicory still contains a slight amount of moisture, from 12 to 15 per cent, and although marketed in this condition, a proportion of the chicory imported from the Continent has usually been "double dried" by a special process, the main object being to remove superfluous weight. "Double dried" chicory will store for a longer period in good conditions than the "single dried".

Actually, the technique of chicory drying is not a simple one, and experienced management of the kiln is required to ensure that the product is of the right quality. When the drying is completed the chicory is bagged, weighed and sewn up ready for dispatch; if not required the chicory is stored in a heap in a dry warehouse, where it remains until dispatched to the roasters and coffee blenders.

FIG. 44.—Lettuce production in unheated Dutch light houses—Variety *May Queen.*

Photo by courtesy of H. B. Wright, Cottingham

[illegible]

FIG. 45.—Crop irrigation by means of rotary rainers.

[illegible]

FIG. 46.—Crop irrigation by means of oscillating spray lines.

YIELDS. The chicory crop has been likened to that of the sugar-beet, but whereas the sugar-beet grower has to contend with the important marketing factor of sugar content in addition to the question of total weight of roots per acre, the chicory grower is concerned only with the latter. It has already been stated that the yields may be as high as 17 tons per acre under favourable conditions. Under unfavourable conditions and under imperfect systems of cultivation the yield may easily be as low as 7 tons per acre. The range of yields open to the grower is, therefore, a wide one, but it necessary to add that in common with all root crops, it does not pay to stint the expenditure on production.

CHAPTER EIGHT

Tuber Crops

The Potato. Considered in terms of yield of food per acre, the potato ranks amongst the most valuable of cultivated crops.

Of South American origin (it was introduced into Europe during the latter half of the 16th century) this crop plant (although unable to stand frost) is accommodating as to soil and climatic conditions. It thrives on a wide range of soils provided there is sufficient depth, and climatically is equally at home in the tropics (at suitable elevations), the sub-tropics and temperate zones. The plant needs from 3 to 5 months warm frost-free weather to mature a crop. Yielding more food *per acre* in dry matter than any other vegetable crop or any cereal crop, it is perhaps not surprising to note that during the 10 years, 1926-35, potato crops in the United Kingdom and Eire averaged 1,123,000 acres yearly, of which 487,000 acres were in England and Wales, 140,000 in Scotland, and 143,000 in Northern Ireland. The average production for that period was 7,517,000 tons, but in 1937, the crop yield rose to 7,622,000 tons. During the late war the acreage was considerably extended. By 1946 the figure for England and Wales had risen to 1,009,000 acres. In 1947 the figure was 941,000 acres. These figures provide an idea of the important status this food crop has attained in modern times.

VARIETIES. The stocks of the so-called varieties of the potato are *clones*, having originated from single seed-generated plants. There is a great range of varieties in any batch of seedlings, but once an individual is selected for further culture it is propagated vegetatively by means of its tubers—this going on as long as it is maintained in cultivation.

All countries have developed their own suitable varieties, the choice being influenced by taste, soil and climatic conditions. In Great Britain where roughly 200 varieties are known, those grown commercially are divided into First Early, Second Early and Maincrop classes, those most favoured for market growing being as follows:—

First Earlies
- *Arran Pilot*
- *Midlothian Early*, syn. *Duke of York* and *Victory*
- *Sharpe's Express*
- *Epicure*
- *May Queen*
- *Ulster Chieftain*
- *Home Guard*
- *Doon Early*

Second Earlies
- *Great Scot*
- *Eclipse*, syn. *Sir John Llewellyn*
- *Royal Kidney*
- *Dunbar Rover*

Maincrops
- *Dunbar Standard*
- *Arran Banner*
- *Gladstone*
- *Majestic*
- *King Edward VII*
- *Kerr's Pink*

Other good maincrop varieties grown to a less extent are *Arran Chief*, *Redskin*, *Arran Consul*, *Doon Eire* and *Golden Wonder*.

Note.—An all-red form of *King Edward VII*, known as *Red King* is now extensively grown. Other than skin colour of tuber there is difference in the two forms. *Red King* usually gives a heavier crop than *King Edward*. In terms of crop yield there is a varietal difference of from 1 to 4 tons per acre under the same conditions of soil and climate.

Place of Crop in Rotations. Except in the case of crops grown in specially early districts, such as in Pembroke and Cornwall, potatoes are mostly cultivated as a farm crop, and grown as part of the root break, *i.e.* after stubble, after the one- or two-year ley, or on land newly broken from old turf, though on the latter wireworms are often troublesome. Early and second-early crops are also taken on market-garden holdings,

usually following either leguminous or root crops, and after clearing are followed by brassica crops. On account of the potato eelworm, however, potatoes should not be grown too frequently on the same land. An important point in potato growing is to *change the land as much as possible*. Finally, the basic principles of potato culture may be simply stated. They are : the use of good seed, the application to the land of farmyard manure, and the thorough cultivation of the soil.

Seed Potatoes. The potato crop is grown from tubers specially saved from the previous year's crop, and termed seed. The tubers used for seed purposes must be healthy, *i.e.* free from virus, eelworm infection and fungoid diseases, if good crops are desired. Size of tuber should preferably be medium, that is, tubers that have passed through a 1⅞ in. or 2-in riddle and stayed on a 1¼-in. one, but tubers of some varieties are occasionally planted "as grown" after dressing over a 1¼ in. riddle and only the largest taken out. Large tubers may be cut into two portions, each with one or more "eyes" or sprouts. Cut tubers should be planted at once and be covered immediately, and should never be allowed to dry out before planting. On an average 1 ton of medium-sized seed tubers are required per acre of second-early or maincrop plantings, but up to 2 tons are needed when grown in the special early areas where closer planting is practised.

All seed tubers should preferably be sprouted in trays in well-lighted frost-proof chitting houses, but unsprouted tubers are also planted, the latter, while being less trouble, giving less satisfactory results, especially with early and second-early crops. Most up-to-date potato growers have specially-constructed chitting houses on their holdings.

Preparation of the Land. Thorough preparation of the land is a necessity for the potato crop. One or two extra ploughings or a cross ploughing according to type of land and preceding crop, are given, followed by deep cultivations with disc and spring-time harrows, the object being to obtain a good depth of broken crumbly soil rather than a very fine tilth. The surface, however, should not be left lumpy. Adequate cultivations facilitate ridging—good ridges cannot be drawn in badly-prepared soil. Every effort should be made to obtain good planting conditions.

Planting in ridges is now generally practised, the ridges being drawn by a ridging (double-breasted) plough. Multiple ridgers, which should preferably be adjustable to row widths desired, are used for large acreages. The ridging immediately precedes planting, and there should be no delay in planting and splitting back to cover the seed and guard against drying out. Ridges for maincrops are usually 28 in. apart, while those for earlies and second earlies range from 22 to 26 in. according to district. When the furrows are to be manured the ridging is done more deeply than when only fertilizer is applied in the furrows.

Manuring the Crop. Few crops pay as well to manure generously as potatoes. All land except newly-ploughed old turf should receive from 15 to 20 tons per acre of well-rotted farmyard manure or good compost. It can be either ploughed in or spread in the furrows after ridging.

The dung or compost dressing should be supplemented with a *complete* fertilizer applied along the furrows on the ridged land. The value of the fertilizer to growth and cropping depends largely on its nitrogen-potash ratio; while the latter should never be lower than the nitrogen content, the actual amount included in the mixture will depend on the amount of manure applied. A fertilizer mixed on the following basis should prove generally suitable for potatoes on average soils of the loam type. Silts and peat soils call for different treatment :—

Sulphate of ammonia 100 lb.
Superphosphate (18 per cent P_2O_5) 200 lb.
Muriate or sulphate of potash 80 lb.

From 800 to 900 lb. of this mixture per acre may profitably be applied on average soils.

The potash may be raised or lowered by 25 per cent according to the dung dressing given the land. Likewise, the nitrogen as sulphate of ammonia may be increased by 25 per cent on land of low fertility and by a half where no dung is given. The keynote of successful fertilizer practice for potatoes is the balance according to soil.

Planting. Potatoes are planted both by hand and machine —mechanical planters of various types being now in use. Hand planting on the whole makes a better job, and is certainly preferable where sprouted seed is to be planted. The seed is

planted from the trays, care being taken to preserve the growths intact.

Spacing depends on variety and type of crop. First earlies are spaced 10 in. to 12 in. in the rows; second earlies 12 in. to 14 in., and maincrops from 14 in. to 16 in. Experiments have shown that there is no gain by using greater spacings than these unless soil conditions are exceptionally good.

Time of planting depends on the district, the risk of damage to the plants by May frosts being taken into account. Early planting, *i.e.* February, is possible in special districts, such as Pembroke and Cornwall, elsewhere March is early enough. Late March and during April is the most suitable period for planting maincrops in average districts. Although the planting of maincrops may be done in the early part of May, the yields of late-planted crops, *i.e.* after April, are usually lower. In other words, the later the planting the lower the yield. Occasionally a roller is sent over the land after planting is completed.

Post-Planting Treatment. Few crops pay as well for post-planting cultivation as the potato. The first operation (about a fortnight after planting) is harrowing to destroy new wood growth and reduce the amount of soil covering the seed tubers. This is done with light short-tined seed harrows or chain harrows reversed. A second harrowing a week or so later is sometimes given.

The next operation is row cultivation to break up the soil to give aeration, destroy weeds and facilitate earthing up later. These cultivations are done at intervals with a heavy horse hoe fitted with "grubber" tines or a scuffler working as close to the plants as possible without damaging them. Some hand hoeing will be necessary around the plants in the rows. Cultivations differ somewhat in practice from district to district.

The final operation of earthing up is seldom omitted. The practice imparts quality to the crop and lessens the risk of Blight infection of the tubers. Earthing-up is best done when the plants are about 12 in. high, and is usually carried out with a horse-drawn ridging plough, a row at a time, although 2- and 3-row tractor-drawn ridgers are used on large acreages.

Later hand-weeding or "spudding" of docks and thistles may be required.

CONTROL OF BLIGHT. In districts susceptible to Blight, spraying with Bordeaux Mixture or other copper fungicide is seldom omitted. Dusting, which is cheaper but not nearly so effective as wet spraying, is also practised. Spraying should be done in time and before growth is too far developed to be damaged by the passage of the machine. Time of spraying depends on the district and is usually not before June except in the earlier southern areas.

Should a crop become badly attacked by Blight the practice of burning it off with a sulphuric acid spray to prevent the disease spreading to the tubers is frequently adopted with good effect.

HARVESTING THE CROP. Early and second-early crops are lifted for marketing while the plants are still green, but main-crops for storage should not be lifted until the growth has died down and the skins of the tubers are set.

Some early crops are lifted by hand, others by ploughs and machines of various types, the spinner type being now generally used. Each row's crop is picked up as lifted, from 12 to 20 pickers being required for average-sized fields, plus men, horses and tip-up carts or tractor trailers for haulage of the crop to the clamping site. When tip-up carts are used the crop is usually picked into skips or skeps, the contents of which are emptied straight into the carts. Where trailers are used the crop is sacked up for transport to the clamp or barn.

The land is finally cleared of the crop by harrowing to expose "missed" tubers, which are then collected.

The crop should be clamped as dry as possible. Clamps should be on a dry site, run north and south and not be wider than 6 ft. at the base. *Bleak exposed situations should be avoided.* The sides should be strawed at least 6 in. thick using straight straw laid lengthways from top to bottom. The straw is weighted down with soil here and there.

Soiling of the clamps should not be done until after "sweating" has finished. When soiling is done the ridge, spanning about 3 ft., should be left uncovered for a further period to provide ventilation. Wet straw should never be soiled over. The final covering of the clamp will be about 6 in. of soil with frequently-placed straw ventilators sloping downwards. If very hard weather should come in the winter a further protecting

layer of soil should be applied to the clamps, or they may be covered with straw to keep out frost.

More potato crops are lost by over-heating than by freezing, and great care is necessary to ensure that crops are clamped under proper conditions and with adequate provision for ventilation.

Fairly large quantities of potatoes may be kept in ordinary frost-proof barns provided the heaps are not too big and deep. The properly constructed potato barn, as used in the U.S.A., is the most satisfactory type of storage for potatoes, but so far it has not been adopted in Britain.

POTATOES FOR SEED. Crops intended for seed in the following season should preferably be lifted on the immature side, *i.e.* while the haulm is still green. The tubers selected for seed should be placed at once in the chitting boxes and be kept in a cool shed or in the shade. Later on when the temperature is lower, they are taken into the chitting house and stored there until planting time.

CROPS. The yield of maincrop potatoes varies very considerably from district to district, and also depends on the variety grown. The average for Great Britain is around 6 tons per acre. Yields of from 12 to 15 tons are regarded as very good crops. Even higher yields have been obtained under favourable conditions.

The Production of Early Potatoes. Specialised production of early potatoes for the British markets is practised in the Channel Islands, the Scilly Isles, Cornwall (Penzance district), Pembrokeshire and the Isle of Wight, the crops maturing in the order given.

Exceptional methods are used in some districts. Suitable land, which is much prized and of high rental value, is usually a light loam much enriched with heavy dressings of compost. In Cornwall this compost, known as "pile", consists of an admixture of farmyard manure, seaweed, beach sand, town or farm refuse, and is supplemented with heavy dressings (up to 10 cwt. per acre) of a complete fertilizer, such as:—

Sulphate of ammonia	1 part.
Superphosphate (18 per cent)	3 parts
Sulphate of potash	1½ parts.
Steamed bone flour	1 part.

Alternatively, as much as 20 cwt. per acre of fish manure or Peruvian guano may be applied to the land.

When the crop is in growth it is customary to apply further stimulating dressings of quick-acting nitrogen, nitrate of soda being favoured. In Cornwall up to 10 cwt. per acre of this top dressing is applied, but beyond this amount there is no cash gain on the fertilizer dressing.

Thorough soil cultivations both before and after planting are given. The composted manure is either ploughed in or placed in the furrows at planting time.

Close planting is practised; in Cornwall up to 40 cwt. of seed per acre may be used. Seed is carefully saved from healthy crops and although Scotch seed was once much in favour it has been proved that healthy (virus-free) once-grown seed is capable of producing both earlier and heavier yields than Scotch, acclimatization being apparently an important factor in producing first-early crops.

The varieties most favoured for culture are *Arran Scout*, *Home Guard*, *Arran Pilot*, *May Queen*, *Duke of York*, *Sharpe's Express*, *Ulster Chieftain*, *Dargill Early* and *Epicure*, *Ben Lomond*, *Vanguard*, *Ballydoon*, *Divernon*.

The Sweet Potato. The climate of Britain is unsuitable for growing this valuable tuber crop, which is even more nutritious than the white potato. The plant, a member of the convolvulus family (*Ipomoea batatas*) is a native of tropical America, and is not only more tender than the ordinary potato but needs a longer growing season (at least 4 months) accompanied by moist, warm weather conditions. Although imported to some extent in normal times sweet potatoes are almost unknown to the British public.

This crop, however, could be grown under glass or in heated pits or frames, as in N. America, provided the temperature can be maintained.

Propagation of the sweet potato is by means of slips or rooted cuttings obtained by bedding the tubers in soil over a hotbed, covered with lights and kept close, the vine cuttings taken from growing crops. The important point to note is that the tubers will not break into growth unless the temperature is high to begin with—a hot, steamy atmosphere being essential.

Under open-land conditions sweet potatoes are grown both

on ridges and on the flat, the plants (rooted slips or cuttings) being set out by hand in rows about 30 in. apart. They could be grown similarly in heated frames or glasshouses in Britain.

Jerusalem Artichokes. The demand for this tuber vegetable is small. The plant (*Helianthus*) is of interest because of the fact that the carbohydrate contained in the tubers does not take the form of starch, but exists as the allied substance termed enulin, which is nevertheless, equally nutritious as human food.

There are several varieties, mostly of French origin. Jerusalem artichokes may be grown on almost any type of soil, provided it is deeply worked, but the heaviest yields of tubers are obtained on well-manured loams. The crop usually responds well to the the use of complete fertilizer of the 1-2-2 type used in conjunction with farmyard manure.

A mixture showing an analysis of 4 per cent nitrogen, 8 per cent phosphoric acid and 8 per cent. potash, should be applied at the rate of from 500 to 800 lb. per acre, according to the soil, before planting the crop.

Planting the Crop. Artichokes are planted like potatoes, small tubers being used; these are either plough in or set with dibbers, in rows 30 in. apart, with 15 in. between the plants. About 10 cwt. of tubers are required to plant an acre.

Cultivation. Cultivation is usually only required in the early part of the season, as the strong growth made by the crop soon smothers all weeds.

Marketing. Jerusalem artichokes are extremely hardy and may be left in the land until wanted. Most growers, however, lift the crop, and clamp the tubers in two grades, those for market and those (usually less than 1¼ in. in diameter) reserved for stock. Half-bags (holding ½ cwt.), bushel boxes and sieves and half-sieves are the types of market package generally used.

CHAPTER NINE

Bulb Crops

The bulb crops comprise onions, leeks, shallots and garlic, but the two first-named are by far the most important. All are various species of *Allium* a genus of plants of biennial character.

Onions are of considerable importance from the point of view of consumption (it is estimated that the annual consumption in Great Britain amounts to approximately 10,500,000 bushels), and from the standpoint of home production in recent times, the crop has occupied an important place. It is a difficult crop for the grower to manage because of the amount of handwork involved.

While climatic factors affect the extension of cultivation in Great Britain, there are many areas possessing suitable climate and soil where the crop can be successfully grown. It has been demonstrated that if proper care and attention be paid to the details of production profitable yields of high-grade onions can be grown. With this crop it is very important that favourable weather conditions should exist both during the growing season, and also at harvest time, so that the bulbs attain a good size and are ripened off in good condition. Admittedly, such conditions are not always experienced in Great Britain.

There are, broadly speaking, three distinct classes of onions, each containing several types. There are the white onions, of which *White Lisbon* is an example; the coloured onions, of which *Danvers Yellow Globe* and *Strasburg* are examples; and the sweet onions, of which *Ailsa Craig* and *Giant Rocca* are examples. The last-named class includes the mildest flavoured onions.

Onions for market may be grown in three ways (1) from seed sown in the open in spring, (2) from plants raised in two ways, and (3) from sets, and the details of cultivation of all the methods are different.

(1) **Onion Crops from Seed.** Some of the best crops are grown in this way, and it is known that early sowing favours both high yield and an early harvest. As a general rule crops are sown during the month of March, as soon as the land can be worked into a fit condition.

VARIETIES. The types and strains of onions are very varied. Those extensively grown for market are of the globe-shaped, coppery-yellow type which seems to have been derived from the *Strasburg* and *Danvers Yellow Globe*. Good stocks of this type are known as *Up-to-Date*, *Bedfordshire Champion* and *Southport Yellow Globe*; they keep well and are always saleable. Some markets, notably those of Lancashire, favour a large brownish-yellow, flattish onion for roping. *Clucas's Market Favourite* and *Unwin's Reliance* are also excellent varieties of this type. *Nuneham*, *Banbury Improved*, *Reading* and *Improved Reading* are all forms of a good type of flat onion of the straw-coloured White Spanish class which keep well and can be recommended for market cultivation. *James's Long Keeping*, a darker coloured onion, has a reputation for good keeping qualities. *Giant Zittau* is a large round yellowish onion which is a good type for crops grown from plants. On the whole, for seeded crops, it is difficult to improve on a good stock of *Up-to-Date* or *Bedfordshire Champion*. The grower should ascertain which type of onion is required in the markets he serves, and which will suit his soil and climate. He must then take steps to secure good strains of those selected for cultivation.

SOILS AND THEIR PREPARATION. Spring-sown onions do best on loams of a lightish texture and good depth such as are found in Bedfordshire, Hampshire and Dorset. The crop also does very well on certain types of well farmed, peaty and alluvial soils, such as are found in the Fens of Lincolnshire, Cambridgeshire and Huntingdonshire.

Autumn ploughing facilities early sowing and provides the surest method of obtaining a good, firm, tilthy seed-bed. Deep

ploughing is essential, and the land should be laid up as roughly as possible. Manure is applied and ploughed in at this time.

MANURING. Loamy soils should receive organic manure, but on peaty soils manure may be omitted. The Bedfordshire onion growers favour the practice of rotting down the manure for two or three years until it has reached a "humified" condition, and applying it to the land in the early spring so that it may be cultivated into the surface soil. This dressing is supplemented with from 300 to 400 lb. of superphosphate and 200 lb. of sulphate or muriate of potash per acre.

Both phosphates and potash are important nutrients for onions and should always be liberally supplied. The following may be taken as a general recommendation for the manurial treatment of onions when no autumn manuring is given:—

For loamy soils.	15 tons per acre of well rotted, " humified ", manure, plus 600 lb. per acre of a 4-8-6 fertilizer.
For peaty soils.	From 800 to 1,000 lb. per acre of a 4-8-12 fertilizer. This treatment could be provided by applying from from 150 to 200 lb. sulphate of ammonia, from 400 to 500 lb. superphosphate (18 per cent.) and from 200 to 220 lb. sulphate of potash, plus filler, per acre.

SEED AND SOWING. Spring-sown onions are drilled in rows varying from 10-15 in. apart, according to the land and cleaning methods employed. In Bedfordshire, where the hoeing is usually done by " crawling", onions are often sown in rows only 10 in. apart. For ordinary hand hoeing the rows need to be 14 or 15 in. apart for ease of working. For mechanised cleaning they should be 18 in. apart. The quantity of seed required varies from 4 to 6 lb. per acre, but on an average 5 lb. per acre of high-grade seed should be sufficient to give a good "plant". A final stand of from 6 to 9 plants per foot of row is considered to be a good stand. Onion seed may be sown as soon as the danger of hard frosts is over, usually early in March. The earliest sowings usually produce the heaviest yields.

AFTER-CULTIVATION AND WEED CONTROL. Shallow cultivations should be given as needed to control weeds, but care should always be taken to avoid nicking the stems of the young plants with the hoes. The rows of plants should be hand-weeded as the hoeing of the inter-rows proceeds. An increasing

use is being made of spraying with diluted sulphuric acid to control weed growth in onions. The spray is a 10 per cent solution of commercial sulphuric acid and water plus a wetting agent such as sulphonated oil, e.g. 10 gallons of acid, 90 gallons of water and one pint of sulphonated oil. Spraying must be done either before or soon after the crop plants appear. Acid-proof spraying machines *must* be used for this work. Such spraying does no harm to the soil but will clear the weeds with little or no harm to the onion crop. Spraying should not be done while the crop seedlings are in the "loop" stage. Flame guns may also effectively be used to control weeds in onions.

Harvesting the Crop. The bulbs should be harvested at the correct stage of maturity, which is when the tops of the plants commence to die off after falling over. At this stage the bulbs may be pulled up freely. It is usual to throw 2 rows of bulbs together to form windrows on firm ground between the rows. The final curing in the field may be effected by gathering the crop into crates, ten of which are stacked in the form of a pyramid, and covered. When thoroughly cured, the onions should be removed to a specially-constructed, well-ventilated, cool store where they remain until required for market. The production of good saleable onions depends considerably on successful harvesting methods. Onions are also kept successfully in cold stores, and experimental work in New Zealand has shown that the system known as heat storage, using temperatures of 72° to 75° F., is also a successful method of keeping *sound* onions.

Marketing. In the onion growing districts it is the practice to make three grades, viz., bulbs over 1¾ in. diameter, bulbs between 1¼ and 1¾ in. diameter and smalls, known as large, medium and picklers respectively. Onions are marketed in bags of either 56 lb. (half-bags), or 112 lb.

(2) **Onion Crops from Plants.** Investigations have shown that the method of raising crops of onions from autumn-sown seed, using a suitable variety, and transplanting the plants the following spring, is a sound commercial proposition for English conditions of soil and climate. In the year 1935, an unusually dry year, a yield of nearly 12 tons per acre was secured with no special treatment beyond careful attention to

detail. Growers with suitable land in search of new crops to grow might well consider putting down a small area of autumn-sown onions as a trial. An acre, or half-acre, of land is sufficient for a trial.

The seed should be sown about the second week in August, on firm land if possible, but a tilthy surface should be secured before sowing. About 40,000 plants are required for an acre of land, and enough seed should be sown to make sure of this quantity. If the seed germinates well, and the plants stand the winter successfully, there may be plants to spare, but onion plants of this type are always saleable in the spring.

Special varieties must be selected for autumn-sown onion crops. The yellow *Giant Zittau* type is one of the best for autumn sowing. A variety that has attracted attention in recent years, and was used in 1935 for the trial that produced a 12-ton crop, is *Unwin's Reliance*. This variety, originally sent out by Messrs. W. J. Unwin Ltd., of Histon, Cambs., develops large flattish bulbs, from 4-5 in. in diameter, of a brownish-yellow colour, very little neck and extraordinary keeping qualities. It is an onion that sells well on the markets, especially in the north, where onions of the full flavoured type are more in demand. *Big Ben*, sent out by Messrs. Sharpe of Sleaford, resembles *Reliance*, and is excellent for autumn sowing. A common failing of autumn-sown plants is that they tend to bolt to seed the following year. *Reliance* and *Big Ben* show very little tendency to bolt. *Autumn Queen* is another good variety for this type of culture.

Manuring. The advantage of an autumn-sown onion crop over the spring-sown is that it can be grown without organic manure, provided the land is in good heart from previously-manured crops. Deep loamy soils are the best, and a clay subsoil is better than one of gravel or sand.

The plants should be transplanted on to the prepared land in early March, during fine weather free from frost. The rows should be 18 in. apart, with 6 or 9 in. between the plants. The wider the space between the plants, the larger the resultant bulbs.

The best form of manurial treatment for these crops is the application of a complete fertilizer about one month after the plants are transplanted. This fertilizer should possess an

analysis approximating 4 per cent nitrogen, 8 per cent phosphoric acid and 6 per cent. potash, and from 800-1,000 lb. per acre of such a mixture should be broadcast over the crop and be hoed in.

CULTIVATION. Growing onions require very careful hoeing by hand. Great care should be taken by the men to avoid nicking the stems of the plants with the hoes. Plants so damaged are ruined. The only object of hoeing is control of weeds.

HARVESTING. Crops from autumn-sown plants are usually ready for harvesting in August, usually a month before spring-sown crops—another advantage. The crop should be pulled and cured in the field, and subsequently stored in well-ventilated sheds until marketed.

While the cost of growing an acre of onions by the method described is not low, a yield of 10 tons of saleable onions (a moderate estimate) should bring a return which would leave a good margin for the grower. The advantage reaped by the grower by using this method is that he is fairly certain of obtaining a good weight per acre.

Crops can also be grown from plants raised from sowings made under glass in January and February, the plants being put out in the open land in March or April after hardening. *Ailsa Craig* and *Premier* are good varieties for this method.

(3) **Onion Crops from Sets.** Crops of onions may be grown by the use of "sets", which are small matured and fully-ripened bulbs grown the previous season, carefully and appropriately stored throughout the winter and replanted in February or early March. Satisfactory crops are obtainable under climatic conditions that preclude the use of direct seeding or transplanting methods.

While set-grown crops mature earlier than those grown from seed or plants they are usually lighter in weight. The cost of sets (unless home-grown) and the cost of planting render large areas an expensive undertaking, but as less cultivation and manuring are needed the crop is by no means uneconomic in certain circumstances, such as where a good direct retail trade has to be supplied regularly. This method is also useful where late summer weather is unsuitable for the ripening of later-maturing crops. A crop of set-grown onions could usefully

precede a plant-grown crop, which in turn, is followed by the direct-seeded crop for later use.

There is normally a good trade in onion sets in Britain, which normally was supplied by imports because of the prevailing idea that a warm climate was required for the successful production of sets. Recent experimental work, however, has shown that satisfactory crops of sets can be grown under English conditions. Growers, therefore, might also undertake the production of sets for this trade.

VARIETIES. The choice of the right variety for each set of conditions is important. The best for set cultivation are the flat-bulbed, golden and brown-skinned types. *Ebenezer* has given good results under trial and is particularly suitable for northern districts. Of the flattened globe type *Sharpe's Big Ben, Danver's Yellow Globe* and *Southport Yellow Globe* are recommended. The red and pale-skinned types (amongst the latter *Ailsa Craig* and *Bedfordshire Champion*) are generally not so suitable.

LAND PREPARATION AND MANURING. The land, which should be autumn-ploughed and left to weather, is prepared for planting as soon as as it can be dealt with in February, If it carried a well-manured crop the previous season no further manuring is needed. High nitrogen fertilizing is not required for set-grown crops of onions and may be positively harmful, but the soil should be reasonably well supplied with potash and phosphate.

The sets, the best size of which is ½ in. to ⅝ in. in diameter (at least 200 to the lb. weight), are planted in rows of 1 ft. apart and at 4, 6 or 8 in. apart according to size of bulb desired. The sets are planted in shallow drills not more than 1 in. deep and should be barely or only three-quarters covered with soil. The drill is a useful help to deal with the natural ''lifting'' that takes place when rooting begins. From 8 to 12 bushels of sets are usually required per acre, although some growers plant up to 20, setting 3 in. apart.

CULTIVATION. Once the crop is planted and growing, weed growth must be kept under control either by hoeing, or hand work. If the bulbs are disturbed or lifted they must be replaced immediately.

HARVESTING. The crop is lifted and dried off in a manner similar to that adopted for other crops. Drying, which may be

completed under glass, or in sheds in districts of higher rainfall, should thoroughly be done. In the U.S.A. a hot-air blast of a temperature of 100° F. to 120° F. is passed through the stacked storage trays to complete the drying.

Growing Onion Sets. These small bulbs may be grown successfully in the southern and south-eastern counties. The principle involved is that of crowding, by which a dozen or so plants occupy a space normally allocated to one plant. Thus, by competing for moisture, nutrients, air and space, the plants mature early.

Three basic essentials are considered necessary in onion-set production—a fine tilthy seed-bed, adequate phosphate content in the soil, and adequate soil moisture to raise the plants.

Sowing the Seed. The seed is either drilled or broadcast. If drilled, seed is used at the rate of from 40 to 60 lb. per acre. Broad, flat and shallow drills are drawn and the seed distributed evenly by means of a spreader. If broadcast, the seed is sown in broad plots about 3 ft. wide at the rate of ½ oz. per sq. yard. The seed should be covered with about ½ in. of soil. It is important to secure the even but heavy rate of sowing to ensure keen competition. The most suitable sowing rate approximates three seeds per sq. in.

Storage. The secret of success with onion sets lies in the storage conditions accorded them after harvest. The crop is forked out of the soil, and after the bulbs have been dried they are thoroughly graded and cleaned. All over ¾ in. in diameter are rejected as being too large for further culture, as the plants produced from them are too apt to bolt, while those of ¼ in. or less are too small. The best sizes are from ½ in. to ⅝ in. in diameter. Experiments* in England have shown that it is possible to produce approximately 1,000 useful sets per sq. yard. These would weigh about 5 to 6 lb. and should produce about 2 cwt. of onions the following year.

Experiments have proved that bolting is largely prevented by the storage temperature of the autumn and winter, the percentage of bolting increasing as temperatures are lowered. A temperature of 75° F. for 14 weeks from late October to February is required to secure a reasonably low percentage of

bolting in the crop. Storage at lower temperatures definitely increases the percentage of bolters.

Thus a grower raising his own supply of sets must provide these conditions, and on the other hand make certain that purchased supplies have been similarly treated. In storage the bulbs are spread 3 or 4 in. deep on trays with provision for air to move freely between. Shrinkage during storage under such conditions will naturally occur, usually amounting to about 25 per cent.

Onions for Pickling. The pickle manufacturers require fairly large quantities of the small, white, ''silverskin'' type of onion. Pickling firms usually prefer to make contracts with the grower, so that they are assured of supplies ahead of their requirements.

Varieties. The Paris Silver-skinned Pickling, *The Queen*, and *First Early Small White* are suitable varieties for pickling.

SOIL. A fairly fertile sandy loam is the best type of soil for pickling onions. A fine seed-bed should be prepared in early spring, and a small amount of superphosphate and potash should be worked in.

SEED. The seed should be sown somewhat thickly in broad drills 8-12 in. apart. The best size of onions for pickling is between ¾ and 1 in. in diameter, and by growing the crop thickly this size is usual. If sown in March, the bulbs usually begin to swell up in May, and the crop may be harvested in July. The crop runs to about 3 tons per acre.

HARVESTING. Dry hot weather is essential for proper harvesting. It is a good plan to gather up the crop and cure the onions in slatted trays, such as potato chitting trays, which may be stacked in pyramids in a situation open to sun and wind. Unless despatched to the factory as soon as harvested, all ''silverskin'' onions are brined, after peeling, immediately.

It should be noted that the small onions from ordinary crops are also graded out and sold for pickling purposes. There

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* Tincker, M. A. H. and Brown, F.C., Onion Production from Sets. Journ. R.H.S. Vol. LXIX, No. 3, 1944.

* Tincker, M. A. H. and Brown, F. C. The Production of Onion Sets. Journ. R.H.S., Vol. LXX, No. 5, 1945.

is a good market for these in the north. They need not be brined but are peeled and despatched as called for.

Saving Onion Seed. Many growers have found that it is worth while working up a reliable strain of onion and saving the seed from year to year. Seedsmen also place contracts with growers for the production of onion seed.

Selected bulbs of any one variety are planted out as soon as possible after the danger of severe frosts is past. The bulbs should be planted from 6-8 in. apart in the rows, which should be spaced 3 ft. apart. The soil for the crop should be deeply worked, and manure may be applied if required.

Frequent shallow cultivations should be given until the flower stems are well advanced in growth; hand weeding should take the place of hoes. The flower stems should be supported to guard against wind damage.

The crop is harvested by cutting the seed stalks about 12 in. below the head at the proper stage of maturity, which is just before the seed capsules commence to burst open. The heads may be dried on canvas sheets in the open or on shelves in a well-ventilated shed or glasshouse, the former being possible only in those districts where the rainfall is light.

The seed is usually lightly threshed out with flails on canvas sheets, but much of it will fall out naturally when perfectly dry. It is difficult to remove the light seeds and trash from the seed without an efficient fanning machine, but small lots may be immersed in water and stirred so that the useless light seed and trash can be floated off. The good seed is then spread out in the sun on canvas sheets to dry. Yields of seed vary from 300 lb. to 400 lb. per acre.

A field of onion seed is shown in Fig. 23.

Leeks. Although perhaps not of front rank importance, leeks are popular and meet with a ready sale in their season—usually, for main crops, the months of January, February and March, when other vegetables are becoming scarce. The leek requires a long period of growth, fully 9 months elapsing from the time the seed is sown until the crop is ready for market.

Varieties. For early crops the *London Flag* has long been a popular market leek. It is, however, sensitive to severe weather,

and should be marketed in early winter. For standing the winter the *Musselburgh* and the *Lyon* are both good varieties. *Carentan* or *Giant Carentan* is a short, thick French type of leek that is also grown for market. On the whole, a good stock of *Musselburgh* is a suitable all-round type of market leek.

Soil. Leeks succeed best in well-drained sandy loams, or silty loams, in a high condition of fertility. Manure need not be applied for the crop if the previous crop was well manured, but a complete fertilizer of a similar composition to that recommended for autumn-sown onions should be worked into the surface soil at the rate of about 600 lb. per acre. If land is poor manure at rate of 20 tons per acre is applied.

Raising the Plants. Leek seed should be sown in a well-prepared seed-bed in March. The plants should be transplanted when well developed, in May and June, and spaced 6 or 9 in. apart in rows 18 or 24 in. apart. Leeks are planted with large dibbers in such a way that the hole in which the plant is inserted is made deep and only partly filled up. The plant will grow and fill the whole and blanch itself as time goes on.

Sometimes, however, leeks are drilled thinly like onions and left to mature where they stand. It is a practice that answers for a certain class of trade.

After-Cultivation. Frequent shallow cultivations should be given and the rows should be hand weeded. Crops intended to stand through the winter may have a light furrow thrown against them in November for protection, but under conditions of a mild winter this is not really necessary.

Harvesting. All leeks should be lifted and marketed before the flower stems commence to show in the spring. The crop is usually dug by hand, and taken to the packing shed to be trimmed, washed and bundled.

The small leeks that are saleable for soups and stews should be eliminated, while the remainder should be tied in bundles of from three to twelve according to market requirements. Before packing the bundles should be washed clean. As a rule the leaves are trimmed back, but the roots are left intact.

Various types of packages are used for marketing, but the returnable 2-bushel box or non-returnable wooden crates

holding from 18-24 bundles make good types of standard packages for leeks.

Leek seed is saved in the same manner as onion seed, except that no transplanting is done, the plants running to seed where they stand. The seed heads mature and ripen very slowly, but the capsules do not open and so little seed is shed. Sometimes drying must be completed in a glasshouse or shed over warm pipes until the heads are brittle enough to be threshed out. Two cwt. per acre is reckoned a good yield.

Shallots. Shallots are gradually becoming a crop of some commercial significance. For long a popular vegetable for private gardens and allotments, only small areas of land are annually devoted to the crop for market. As a general rule there is little demand, and growers are not advised to grow shallots unless they possess an assured outlet, such as a pickling contract or a contract for sets from a seed merchant.

As is well known, the shallot differs from the onion in that it does not form a single bulb but a kind of composite bulb, consisting of many small bulblets called "cloves". The crop is propagated by planting these cloves, or sets, singly in rows 1 foot apart, with a space of 6 in. between each.

As a rule small sets give not only the larger crops, but a higher proportion of large bulblets. Large sets give a higher proportion of smalls so should preferably be used to grow planting size sets for sale. Shallots suffer from a virus disease and, therefore, only healthy crops should be saved for replanting. Attacked plants have yellow stunted foliage.

Shallots require a light, rich soil that dries out quickly in July, when the crop is ready for harvesting. Manure need not be applied if the land is in good heart, but a fertilizer mixture similar to that recommended for onions may be used with advantage.

Shallots should be harvested in a manner similar to that employed for onions. They must be thoroughly dry before being stored, and should be handled carefully.

Garlic. There is a limited demand for this strong-flavoured member of the onion family, mainly in the London markets and big provincial cities where there is a call for it from a certain class of restaurant.

It does well on the types of soil that grow onions well, and should have the same tillage and manurial treatment as onions. A light, well-manured sandy soil is the best.

Garlic resembles the shallot in that it produces a group of small bulblets, or cloves, fastened together and covered with a thin membrance-like skin. The cloves are planted singly, 4 to 6 in. apart, in rows about 1 ft. apart, or wider for mechanical cultivation. The cloves should be planted deeper than those of shallots and are best covered by about 1 in. of soil.

The growth dies away about July when the crop is harvested by running a cutting bar beneath the rows to loosen out the bulbs which are first cured in windrows in the field and later in stacked crates as in the case of onions. The tops are trimmed off when thoroughly dry and the bulbs are stored in a dry, cool, well-ventilated store (not with onions). Garlic bulbs are usually marketed in open-mesh bags (net bags) holding various weights, usually 20 lb. and 40 lb. Sometimes the bulbs are not trimmed but the tops are plaited to form ropes of garlic, and are sold in this manner—the rope weighing 6 lb., 12 lb. or 24 lb. according to the market served.

CHAPTER TEN

Salad Crops

Lettuce : Outdoor Crops. Although cos lettuces are readily saleable, especially in some markets, on the whole the public prefer cabbage lettuce, and usually sales of this type can freely be effected throughout the year. The earliest crops come from glasshouses and frames, but crops of over-wintered outdoor lettuce are ready for cutting from the middle of May onwards and by skilful management of cropping a continuity of supply can be secured throughout the summer months, and well into the autumn. The market demand for lettuce usually strengthens about the middle of May when the weather becomes warmer and the public preference for salads is more pronounced. Nevertheless, the crop is often "chancey" because of demand falling off or of bolting caused by hot weather.

Soils. The early crops of outdoor lettuce can be grown on any type of light, loamy soil, provided it is fertile and contains a fair amount of humus. Later on in the season moisture is the chief factor controlling production and the best lettuce crops are grown on cool, moist soils, particularly the peaty soils, such as the fen-lands of Cambridgeshire and the moss-lands of Lancashire and Cheshire. On such soils it is a common practice to make a succession of sowings in the open from the first week of April until about mid-July. Re-sowing can be done after the earliest crops are taken or it is possible to sow spinach, turnips or a late crop of peas as follow-on crops.

It should be mentioned that the use of overhead irrigation makes it possible to grow lettuce on dryer types of soil during the summer months. Many growers are now using this system.

CABBAGE LETTUCE VARIETIES. There are several distinct types of cabbage lettuce suitable for field cultivation, but those described below are most suitable for market in Britain. Contrary to experience on the Continent and in America, the British public perfers the "Butterhead" types, all of which possess leaves that appear to have a soft, oily, or buttery, texture, to the crisp or curled type, although the latter find a market in hot weather. There are large, medium, and small types. Some are hardier, some are of a darker green and others stand better. The large and medium-sized types are the most suitable for market.

Big Boston of Trocadero Type. This is one of the best market cabbage lettuces, being of a large, hardy type, making a firm heart and suitable for both winter and summer crops. The various strains of the type are known as *Trocadero*, *Big Boston*, *Sutton's Ideal*, *Unrivalled*, *Borough Wonder*, *Market Favourite*, *Trocadero Improved.* The first three develop leaves with a slight reddish tinge and are perhaps more suitable for winter crops. The remainder are green forms and very suitable for summer crops.

Hardy Green or Hammersmith Hardy Type. Also a hardy type suitable for crops to stand the winter. It is a dark green and rather coarse lettuce, but some varieties such as *Lee's Immense*, are lighter in colour, It is a useful lettuce where over-wintered crops are desired, as it usually stands the most severe winters without protection. *Schofield's Hardy Winter White*, *Yate's Winter White* and *Harrison's Green Winter*, are also good strains of this type.

Arctic, *Arctic King*, *Imperial* are also very hardy varieties of lettuce of a distinct type.

All-the-Year-Round Type. A black-seeded type suitable for growing at any season. Although of medium size it is a good market lettuce. There are some improved strains that are rather earlier but slightly smaller, known as *All-the-Year-Round Improved*, *Early Market All Heart*, *Longstander* and *Matchless.*

Feltham King. A very good market lettuce resembling *All-the-Year-Round*, but white-seeded, the same as the French *Gloire de Nantes*. It stands dry weather well and is slow to run to seed.

May Queen Type. This type, like *All-the-Year-round*, is suitable for general cultivation, i.e. both winter and summer crops, and also frame and glasshouse crops. It is of medium size, lightish green in colour, with outer leaves slightly tipped with red. There are, however, a few strains without the tinted leaves. A good type for raising in frames for early outdoor crops. *May King* and *May Duke* are similar to *May Queen*.

The above, while not a complete list of "butterhead" types of cabbage lettuce, are the most suitable for market purposes. The very small "butterhead" known as *Tom Thumb*, has only limited value for market.

The Curled or Crisp Types. 1. *Heading*. These curled, heading lettuces, which are so popular in America, are grown for market in Britain but not so extensively as the other types. Their chief merit is that they stand a long time in summer without bolting. In all forms the edges of leaves are frilled and the texture is crisp and of good flavour. *Iceberg*, a good example of this type, is pale green, lightly tinged with brownish-red and forming good hearts. *Hanson* (syn. *Royal Malta*), is a bright pale green, large lettuce, with a loose heart. *New York*, which originated in Europe as *Neapolitan* or *Chou de Naples*, and is known in Britain as *Wonderful* (Webb) is darker in colour, untinted and rather looser growing, though forming good hearts, than the others of the group. It has been much renamed. It stands hot weather and dry conditions better than any other cabbage lettuce. *Ohio Cabbage*, a light green and much-frilled form was originally known in the U.S.A. as *Denver Market*, and has been named *Favourite* (Sutton) in Britain. It stands a long time. *Drumhead*, syn. *Malta*, is a large, rather coarse lettuce, darker in colour and less curled.

2. *Non-heading*. This non-heading, curled or crisp type is very popular in American markets on account of its flavour, but is little grown in Britain. *Prize Head*, known in Europe as *American Gathering*, *Boston Curled* and *Grand Rapids*, are well known examples.

Cos Lettuce. This class contains fewer distinct types than the cabbage class. Some markets prefer a dark green type of cos lettuce whereas others like the lighter green type. A desirable market variety should develop good hearts and fold

naturally although the markets prefer a "tied" lettuce. Tying assists the lettuce to heart up and many growers now slip rubber bands on each plant, a week or 10 days before they are ready (size No. 18 suits the purpose well).

Bath Cos Type. This is a generally grown hardy winter type of cos lettuce. Its outer leaves are tinted reddish-brown. The heads are only medium sized. Known as Black Seed Bath Cos.

Hicks's Hardy Winter Cos Type. This is a hardy type of cos lettuce for over-wintering in the open. It is also suitable for spring sowing in districts that possess a less favourable climate in the early months.

Paris White Type. A favourite market self-folding type. *Varieties* medium-sized and medium-green in colour. *Trianon, London White, Crystal Cos, Prince of Wales, Sharpe's Standard White, Sutton's Superb.* Large-sized varieties—*Jumbo Cos, Exhibition, Alexandra White, Kingsholm.*

Paris Green Type. A type similar to *Paris White* but of a darker green colour. A good market type where dark green lettuces are required. Varieties are known as—*Paris Green, St. Albans Allheart, Lobjoit's Green Cos, Vaux's Self-folding Green.*

Raising the Plants. Plants of both cabbage and cos classes for standing the winter and cutting in early summer are raised from seed usually sown in the open in August. In warmer districts, such as in parts of Cornwall, the seed may be sown as late as September. The plants are transplanted in October. *Bath Cos, Hicks's Hardy Winter White* (Cos types), and *Trocadero, Imperial, Lee's Immense, Hammersmith Hardy Green, Arctic, Arctic King, Winter Crop* (Cabbage types) are very suitable for these crops. In order to maintain a supply of lettuce over a long season a unit of frames or Dutch lights is necessary for raising plants.

Plants for early summer crops of less hardy types can also be raised by sowing seed in frames or Dutch lights in October. The plants are wintered in the frames and transplanted in late March or early April. *Market Favourite, May Queen, Feltham King, All-the-Year-round,* are suitable varieties for this method. A good planting distance for cabbage lettuce is 12 in. × 9 in.

=58,000 per acre. Cos lettuce should be planted in rows 18 in. apart, with the plants not closer than 10 in. according to size of variety. It is important to avoid planting in shallow depressions on the surface of the land.

The seed of summer crops of cabbage lettuce is normally drilled in rows from 14-18 in. apart, and the seedlings are thinned so that the plants stand 10-12 in. apart in the row. Usually from 1½-2 lb. of seed are used per acre. The seed should be mixed with dry, sifted wood ashes to facilitate drilling and a thin distribution. The spacing in the row, called "singling" or "blocking", is done by hand, the workers using small draw hoes for blocking out. As a rule lettuce seed germinates quickly, but germination is often delayed in dry weather. The large lettuce growers usually drill from ½ acre at a time at fortnightly intervals according to the supplies required.

In Cornwall, where a speciality is made of out-of-season crops of lettuce sowings are made as follows :—

July varieties	*Borough Wonder.*
August varieties	*Improved Trocadero, Imperial.*
Early September varieties	*Winter Crop, Majestic, Imperial, Spring Beauty.*
For Frame growing—October onwards varieties	*May Queen, French Frame, Blackpool.*

Land Preparation. Land for lettuce should be ploughed well in advance of the planting or seeding, so that it has time to consolidate. For summer crops that are drilled the land should be firm but have a good tilth. The land should be rolled after sowing. When cultivating for seeding, care should be taken not to loosen up the land as this causes loss of moisture.

Manuring. Lettuce is not actually a gross feeding crop, its preference for well-manured land being mainly associated with the moisture factor. Under irrigated conditions less manure may be allowed, but it has been found that the crop responds to the stimulating effect of potassium-nitrate fertilizer dissolved in the water used for irrigation. The manurial treatment of lettuce must be based on (1) the type and amount of manure applied to the previous crop; (2) the length of time the land has been under cultivation; and (3) the season of cropping.

On loamy soils a complete fertilizer is needed for lettuce, as both phosphates and potash influence the quality of the crop. On peaty soils the phosphate ratio should be raised. Nitrogenous top-dressings, such as nitrate of soda at 1 to 1½ cwt. per acre are very useful stimulants for this crop, care being taken to prevent the fertilizer touching the foliage of the plants to avoid scorching.

Some amount of organic manuring is preferable for lettuce on loamy soils. For example, 400 lb. of hoof and horn meal, 300 lb. superphosphate and 100 lb. of sulphate of potash per acre form a good treatment for land that was well manured for a previous crop. Land not manured previously should receive 10 tons per acre of well rotted manure at ploughing time, plus from 500-700 lb. of a fertilizer approximating a 4-12-6 fertilizer at planting time. A satisfactory fertilizer for Fen soils or other peaty land would be from 600 to 800 lb. of a 5-10-5 analysis per acre. For example :—

150 lb. sulphate of ammonia	=N. 30 lb.	
400 lb. superphosphate (16%)	=P_2O_5. 65 lb.	
70 lb. sulphate of potash	=K. 35 lb.	
Total 620 lb.		Approximate analysis 5-10-5

Cutting and Marketing. The method by which lettuce is cut and packed has a considerable effect on the prices realized for the crops. The crop should be gone over at frequent intervals so that the lettuces are secured, as they mature, in their best condition. They should be carefully cleaned by removing all decaying leaves, dirt, etc., and should be graded for size, and, if necessary, quality. Badly hearted and bolted lettuce are not wanted on the market, and the dispatch of such produce serves only to congest the markets and cause trouble to salesmen. It is best to plough in a spoiled crop.

Cos lettuce are often pulled and trimmed so as to leave a "stub-root". Other growers screw them off. Cutting is not advisable for cos lettuce as they bleed and wilt more quickly then when pulled. Cabbage lettuce is cut carefully with a sharp butcher's knife at ground level. During hot weather all lettuce should be cut either in early morning or late evening. In very hot weather it pays to pre-cool lettuce if facilities are available.

The early morning is really the best time for cutting lettuce

during the warmer months. Lettuce cut at that time of day will keep fresh twice as long as lettuce cut during the day or in the evening.

Lettuce grown in the open is usually packed in the field but another method is to convey the produce to a packing shed for the final grading and trimming. Light non-returnable wooden crates holding 24, or 30 or 36 are the best packages for cabbage lettuce. Crates are also the best package for cos lettuce for long distance marketing but in the London district and the vicinity of other large cities the produce is often sent in returnable bushel or two-bushel boxes. The "score" count of 22 heads is also a market unit in the London district.

Growing Lettuce Seed. The production of lettuce seed requires a very favourable climate, and in consequence much of the seed used in Great Britain is grown abroad, mostly in California. Seed can, however, be grown under English conditions if care is employed and the season is dry and sunny.

Plants for the seed crop should be raised as early as possible in the spring or be over-wintered in frames. They should be put out in the open early in March in rows 24 in. apart with 15 in. between the plants. The hardy types can, of course, be over-wintered in the open in the usual way.

Frequent shallow cultivations with hand hoes should be given to encourage growth and keep down weeds.

The crop should be carefully rogued when the plants are fully developed and before they start running to seed. All plants that have departed from the true form of the variety or type should be removed, as well as all plants that exhibit a tendency to run to seed quickly. The capacity for "long standing" is a very desirable feature in a market lettuce. If the type grown forms very dense and hard heads the top of the head should be cut across both ways with a sharp knife, but with care in order not to damage the centre bud ; this "slashing" enables the bud to break out and grow a straight flowering stem. As a rule, the plants flower in August. Very little cross-pollination takes place with lettuce, but each crop of seed plants should be well apart from others. The crop is cut when the seed heads commence to turn yellow, and show a little fluff. When dry enough the heads are flailed out on large canvas sheets. The seed is cleaned

in special fanning mills and should be stored in a cool, dry place. Yields of seed are not as a rule high—2 cwt. per acre being an average.

Outdoor Tomatoes. Tomatoes are always saleable, and outdoor crops, which ripen during August and September, can usually be marketed at remunerative prices. The success of the outdoor tomato crops depends to a great extent on the weather, for if the months of August and September are excessively wet blight disease may intervene, and the fruit is slow in ripening and tends to crack on the plants before it is ready for picking. On an average of several seasons, however, the crop does very well, and as they find the crop well worth including in their cropping programme, many market growers plant an area of tomatoes every season. Yields up to 10 tons per acre are not unusual. Trials have shown that yields averaging 4 lb. per plant are obtainable in a number of counties. It is very important to control effectively by spraying methods the destructive blight disease, *Phytophthora infestans*. It has been demonstrated that spraying the plants at blossoming time with chemical compounds of the growth hormone type, notably indolebutyric acid, increases fruit setting.

Varieties. Varieties especially adapted for outdoor culture and of good disease-free stock should always be grown. The market grower requires a good strain of an early maturing, productive, hardy variety that produces medium-sized, smooth, well-coloured fruits with solid flesh and freedom from core and which ripen 75 per cent. of their crops out of doors.

Some recommended varieties are *Carter's Sunrise*, *Sutton's Best of All*, *Stoner's Exhibition*, *Market King*, *Radio*, *Harbinger*, *Hundredfold*, *Potentate*, *Earliest of All*, *E.S.I.*

Soil. Deep loamy soils are the best for tomatoes, and land set aside for the crop should be well prepared and manured in the previous autumn. Up to 20 tons of manure per acre should be applied, and the subsoil should be moved if necessary. Early ploughing is important as the land must be well settled by the time the plants are put out.

Raising Plants. Much of the success with outdoor tomatoes depends on the method of raising the plants. The raising of

well-hardened plants, which at the same time are not overgrown or woody, requires skill. On the whole plants raised in glasshouses are not so suitable as those raised in frames. The best plan is to sow the seed in a heated glasshouse in March, and transfer the seedlings to size 60 pots or to boxes when the second pair of leaves are showing, using the John Innes composts for both seed boxes and pots. After a day or two the plants are transferred to frames, such as those illustrated in Fig. 43, and allowed to grow steadily until about the third or fourth week in May or first week in June, according to the district, when they are put out in the field. A steady continuous growth, with a proper hardening off just before planting time, must be secured if the plants are to go away well and develop a good cropping condition without loss of time. Trials have shown that plants raised in pots give on an average ½ lb. of fruit more than those raised in boxes.

The plants are planted in various ways; 3 ft. square (4,840 plants per acre) being used for mechanical or horse cultivation, or a distance of 3 ft. between rows with plants set 18 in. apart is suitable. The Italian method of double rows of plants spaced 2 ft. apart, with 4 ft. between the double rows, has also been used with success. With this method the stakes of each two plants are inclined and tied to a single wire 4 ft. above the ground, the sloping effect being regarded as more beneficial to the crop when it is more freely exposed to the sun's rays. The rows should preferably run north and south. Nothing is gained by having an excessive number of plants on the land. Each plant must have a good stake; canes may be used if the rows are wired to give added support.

Cultivation and Manuring. In addition to the manure applied when the land is ploughed, from 600 to 800 lb. of a complete fertilizer high in potash and phosphate should be applied at planting time. As tomatoes are able to use considerable amounts of potash, the amount of this nutrient for outdoor crops should be about equal to the amount of phosphate, i.e. a 1-2-2 nutrient ratio. A suitable analysis for a tomato fertilizer would be approximately 4-8-8.

The land should be frequently cultivated between the rows to aerate the soil and control weed growth. As a rule, the better the cultivation the heavier the crop produced. The view

prevails amongst some growers that it is unwise to water outdoor tomatoes, but during their earlier stages of growth the plants. will benefit from a good soaking during dry spells. The application of water later on may crack the fruit. The plants, pruned to one stem, should be stopped at the fourth truss of fruit. It is a good plan to mulch the land lightly with barley straw between the rows to conserve moisture.

MARKETING. Outdoor tomatoes should be gathered as they colour. The fruit need not be left on the plants until it is deeply coloured. It will usually finish colouring after packing. The fruit should be carefully graded and packed in 12 lb. or 14 lb. tomato boxes or chips, all blemished and cracked fruit being rejected.

Some growers have special ripening rooms artificially warmed and thermostatically controlled. The fruit is gathered as it shows first signs of colouring and ripening is completed in the ripening room. Such rooms are a good investment where any appreciable acreage is grown. They must be so constructed as to be warm and air-tight, so providing the correct conditions for ripening, the principle being the same as that employed for banana ripening rooms. Other growers ripen their fruit under Dutch lights which are shaded with whitewash, the fruit being laid on clean straw. This is a useful way of finishing the end of season pickings which show little colour. Some growers cut the whole plants with fruit intact and transfer them to the Dutch lights at the onset of frost.

SAVING SEED. It is a good plan to save seed of tomatoes, as a good reliable strain, free from seed-borne diseases, is thereby secured. Few of our crop plants respond so quickly to careful selection as the tomato. The best method is to mark healthy plants bearing good crops, and save the whole of the fruit from them for seed. The seed is obtained by pulping the ripe fruit and removing the seeds and juice from the coarser material. The seeds and juice are then fermented in a wooden tub, or other receptacle, until the pulpy envelope surrounding each seed breaks down, so that the seed may be washed clean and dried. Care must be taken not to over-ferment the seed, as that impairs its vitality. While fermenting, it should be frequently stirred. In place of fermentation commercial hydrochloric acid—1 pint to 22 lbs. of fruit pulp—may be used.

Watercress. Watercress is a valuable green food because of its high vitamin and mineral content, and is a popular salad crop, and one which always meets with a good and regular demand. The crop is available for marketing more or less throughout the year, with a peak period of supply during the months of March, April and May.

The cultivated watercress of the markets is grown in specially constructed beds that are usually fed with spring water which being derived either from natural springs or from artesian wells, is warmer in winter than the water of streams and so promotes active growth. Crops of summer cress are also grown in the water derived from nearby running streams as this is then warmer than the spring water. Watercress will not thrive unless an ample supply of lime is present both in the beds and in solution in the water which passes through the beds, which accounts for the water usually being drawn from the chalk and Lower Green-sand formations. In this connexion it is noteworthy that most of the large commercial beds are either located in the vicinity of chalk formations, or draw their water from the chalk. There are about 800 acres of beds in England, mostly in the south.

Construction of the Beds. Hygienic methods of production are very desirable, and to this end the beds should be constructed with retaining walls of faced concrete. The bottom of the beds should be of clean sand or chalky gravel. The width and length and general lay-out of the beds should be according to the flow of water available, and the water supply should be so arranged that it is always under the grower's control. A good, pure water supply, which does not fail, is very essential, and clean methods of production should always be practised.

Types and Propagation. The *Brown Winter* cress, which is a hybrid form, is usually grown for winter and early spring cutting, and the *Green Summer* cress for summer cutting.* Although it is readily raised from seed watercress is usually propagated from cuttings taken from established plantings of definite types, when the beds are remade after the cropping

* The Green Summer Cress is a variety of the wild watercress—*Nasturtium officinale*, but the Brown Winter Cress is a hybrid from that and another species—*R. uniseriatum*.

period. The beds will remain in production, once established under favourable conditions, for several sesaons with only an annual "re-dressing", but it is customary to clean out the beds thoroughly and replant with a fresh stock once a year and at least every two years. Beds for autumn and winter cutting are usually replanted in May and June, and those for spring and summer cutting in September and October, to provide a succession of cuttings. The Green cress may be grown throughout the year if required, but the Brown cress is suitable only for winter cultivation.

It has been found that this crop responds to the use of superphosphate which is applied to the beds as a fertilizer at the time of replanting. Up to 20 cwt. per acre of a 18 per cent superphosphate can be effectively used. Some waters are deficient in nitrates and the use of nitrate of soda as a fertilizer may be beneficial under such conditions.

MARKETING. The cress is usually cut from early morning until about noon, so that the day's cutting can be bunched (if bunching is practised), packed and dispatched to market in time for the following morning's sales. During the summer months the cress is often cut at daybreak and dispatched to market in time for sales the same day, usually without preliminary bunching. Yields of 10 tons per acre are regarded as above average. Usually they range from 6 to 10 tons.

The cress is marketed either bunched or unbunched. Unbunched cress is usually packed as cut and dispatched in wicker half-flats and quarter-flats, the former containing from 17-25 "hands" of cress each of 1¼ lb. or more. Bunched cress, now in general demand, is carefully prepared for market in the packing shed and dispatched in 12-lb. chip baskets containing 3 dozen bunches, in half-flats containing 8 or 9 dozen bunches, or in larger hampers containing 12 dozen bunches. The packages are usually immersed in cold spring water and then drained off before dispatch. No other commercial vegetable crop requires such expeditious handling as watercress.

Green Onions. Green onions are usually in good demand during March, April and May, and to meet this demand seed of white types of onions, such as the *White Lisbon*, is sown in August, the plants standing the winter, and the whole crop

being cleared in the following spring. The thinnings of spring-sown crops for bulbs are also sold for salad purposes later in the summer. Further sowings are made in early spring.

SOIL. Green onions as autumn-sown crops are most successful in the milder districts ; it is, for example, a notable crop in the Evesham district of Worcestershire, where the winters are milder than further east. The crop should be sown on well-drained loamy soil of good depth. Manure is not necessary, though some growers prefer to give a light dressing, but the land should be well consolidated and possess a good surface tilth. If the plough is used after the preceding crop the land should be well rolled to reduce it to a solid condition. The seed, sown thickly, at the rate of from 25-30 lb. per acre, should always go in on a firm seed-bed.

MANURING. On lighter soils, where potash may be short, it is a good plan to apply from 100-150 lb. of muriate of potash per acre before sowing the seed. This assists in hardening the growth of the plants, so enabling them the better to stand the winter. During the month of February an application of from 100-120 lb. of nitrate of soda per acre will act as a stimulant and bring the crop along quickly for market.

CULTIVATION. The land should be kept free from weeds and the rows of plants hand weeded when required. Sulphuric acid sprays may be used.

MARKETING. The green onion crop is pulled and if necessary may be bunched in the field, forks being used to loosen up the plants before pulling. The onions should usually be marketed in March and April before bulbing commences. As the size of the bunch varies according to the district and markets served, the latter's requirements should always be ascertained before supplies are forwarded. Rubber bands, raffia and osier twigs are used for tying the bunches, again in accordance with local demand. The bunches should be washed clean before dispatch.

Medium-sized wooden crates and wicker hampers that permit of adequate ventilation are better types of market packages for green onions than wooden boxes or larger hampers, which tend to over-heating of the produce in transit.

Mustard and Cress. White Mustard (*Brassica alba*) and the Common or Plain-leaved Cress (*Lepidium sativum*) are grown in

large quantities as market salad crops and sold together as mustard and cress. The crop is usually grown in glasshouses and there are establishments where a speciality is made of its production and sale. Rape is used as a substitute for mustard.

The crops of mustard and cress are usually grown separately, as the cress takes rather longer than the mustard or rape to reach the same stage of growth (first seed leaves), at which the cutting is done. Rape takes a little longer than mustard.

The crop is mostly grown on the floors of low, heated glasshouses, or during the summer months in double-span Dutch lights. It is necessary always to afford protection of some kind, or the crop may be badly damaged by heavy rain. A fine, rich tilthy soil should be used and a temperature of from 60-65°F. maintained in the house. The seed, which is usually "chitted" prior to sowing, should be broadcast thickly but evenly, and only a light dusting of fine soil, if any, should be given as a covering. The beds should be well soaked before the seed is sown. No manures or fertilizers are used for this crop, but the soil should be of a fertile character, rich in humas. A little fine lime is beneficial if raked in when preparing the beds. After sowing the beds are covered with hessian until the crop is about 1½ in. high.

MARKETING. This crop is usually marketed in punnets, either round or square punnets being used, the mustard and the cress being packed either in separate punnets or mixed together. Cutting is done with a special type of sharp knife and requires skill, care being taken to exclude soil and other undesirable matter. The punnets are packed in wooden crates containing 3 or 4 dozen.

Cucumbers. Although the bulk of the supply of cucumbers is normally grown under glass, the outdoor "ridge" type of cucumber has long been established as a market garden crop. With the growth of the glasshouse industry, however, the demand has declined, although some sections of the public still prefer cucumbers grown in the open, as on the whole they are of better flavour. The smaller fruits of the ridge cucumbers are also in demand for pickling, but in recent years special varieties have been developed for this trade, and the pickle manufacturers now draw most of their supplies from growers who make contracts to grow the right article. The small, ordinary ridge

cucumbers are, however, often in demand by the pickling trade for cutting up and are commonly referred to as "slicers". All cucumbers are of the species *Cucumis sativus*.

Outdoor cucumbers thrive best during warm seasons, although the yields are reduced if the weather be too dry. The crop suffers from the effect of prolonged wet weather.

Varieties. Among varieties the *Bedfordshire Prize Ridge* used to be much grown in Bedfordshire and still is to some extent. *Stockwood Long Ridge*, *Withers' Ten Weeks* and *Cheltenham Long Ridge* are other varieties of merit. The smoother kinds appear to sell best. Mosaic disease, a plant virus, is a source of trouble with these plants. Mildew usually attacks the plants in early autumn and finishes the crop. Some varieties resist mildew better than others.

Soils. As a general rule the better drained, loamy types of soil are the most suitable for cucumbers, the lighter types of soil lacking moisture-holding capacity. Silty and clay loams are very suitable provided a fair supply of manure is given to improve the texture and keep them open.

Manuring of the Soil. The question whether manure should be applied depends on the type of land and previous cropping. Cucumbers should preferably follow a crop that was well cultivated and manured, such as potatoes or cabbage. The best manurial treatment is a moderate application of manure, or compost, which may be either spread evenly and ploughed in, or ploughed in where the rows are to go. Only well-rotted manure should be used for cucumbers. Deep ploughing is essential, and the land should be well cultivated before the seed is sown.

Sowing the Seed. Cucumber seed should not be sown in the open until the soil is thoroughly warmed up and all risk of frost has gone. In this country the second half of May or early June is quite soon enough to sow the seed of this crop, and there is nothing to be gained by earlier sowing. The seed should be sown in shallow drills drawn out 4 or 5 ft. apart. Another good method is to have 2 rows spaced 30 in. apart with a space of 5 or 6 ft. between the pairs of rows. The seed should be placed 6 in. apart in the rows and when the plants are up thin out to 12 or 18 in. apart. From 1½-2 lb. of seed are required

to the acre. In colder districts the seed may be sown on the warm sides of ridges running east and west.

Seed may also be sown under the continuous type of cloche to obtain early crops. Plants for early crops may also be raised in pots under cover of frames.

After-Cultivation. The crop should be freely cultivated and all weeds kept down. When the plants are commencing to run, a complete fertilizer high in phosphate should be applied along the rows and be hoed in. This should show an analysis approximately 4-12-4, where no manure was used, or 5-10-5 where manure was applied. About 500 lb. per acre of this fertilizer should be given. Some growers apply from 400-500 lb. superphospate per acre before sowing the seed, and give nitrate of soda as a top dressing when the plants commence to flower. Cucumber seed is sensitive to the action of fertilizer salts hence the reason for applying mixture after the plants are up.

Marketing. Ridge cucumbers should be cut while still fresh and green, all yellow fruits being discarded. The plants should be gone over regularly, usually three times weekly during the full cropping period.

Wooden returnable boxes or non-returnable wooden crates make the best market packages. A little fresh grass or hay should be used for packing material.

Gherkins for Pickling. The European gherkin, the cornichon of the French growers, is not a distinct species of *Cucumis*, but a small form of cucumber, the fruits being from 4-6 in. long, and is cultivated in the same way as the ridge cucumber. The varieties grown are mostly of Continental origin, such as the *Small Paris Gherkin*, *Massy Green Pickling*, *Meaux Green Pickling*. The *Boston Pickling* and *Snow's Perfected Pickling* are two varieties of American origin. As a rule the cultivation of gherkins is undertaken on the basis of contracts with firms of pickle makers. The West Indian gherkin is a distinct species, *Cucumis anguria*, and bears smaller fruits, about 2 in. long and spiny. This type of gherkin is little grown commercially, the Paris and American types being generally preferred.

Gherkins are often a profitable venture if a favourable contract with a pickle factory can be secured. It is a good plan

to grow gherkins as a companion crop with early potatoes, as the plants appreciate the protection and partial shade of the potato rows in the early stages of growth.

By this method of growing the crop deep drills are drawn out 4 ft. apart with the potato plough. The drills are then manured with well-rotted dung or compost and the soil is turned back to cover it. The rows so treated are marked before they are covered in. The potato drills are then drawn midway between the drills, manured and planted.

The gherkin seed is sown not earlier than the end of May on the centre of the prepared drills, two seeds being inserted at intervals of 9 in. either in a shallow drill or with a blunt-ended dibber. About 2 lb. of seed per acre should be allowed. Thus potatoes and gherkins occupy the land in rows 2 ft. apart until the former are cleared in late June or early July, after which the latter have the whole run of the land.

After the potatoes are lifted the land is cultivated at intervals until growth impedes the work. No stopping of the plants is necessary as they will break laterals and run naturally.

The crop is gathered when the gherkins are about the size of a man's thumb and running about 12 to the pound. Cutting commences in earnest towards the end of July and continues until frost kills the plants. It is necessary to go over the plants two or three times weekly. The crop should be handled carefully, each cutting being dispatched immediately to the factory in field boxes or bags for brining. Sometimes brining is done on the holding as with cauliflowers.

Chicory. The forced Witloof chicory (see Early and Forced Crops, Chapter XII) is also used as a salad crop, but the chicory grown so much on the Continent for salad purposes is the *Paris Chicory* or *Barbe-de-Capucin*. The roots of this chicory are grown in the same manner as the Witloof, and when forced in gentle heat and darkness in winter, not like the Witloof chicory, produce the highly esteemed blanched chicory which often commands a ready sale during the winter months as a salad.

There is no special difficulty associated with the production of this crop. The point of importance is to secure the correct varieties. There are in addition to the common chicory, the *Broad-leaved Parisian* or *St. Marc* and also the *Magdeburg* or

Coffee chicory, the smaller roots of which are used. In normal times it is probably safer to obtain the seed from a Continental source.

Endive. Although endive as a salad crop has never reached in Great Britain the status it enjoys on the Continent, it is grown by market gardeners to some extent in certain districts. The crops are not usually available until the autumn months. Endive (*Cichorium endivia*) belongs to the chicory family and unless the plants are well blanched they possess a bitter taste quite different from the flavour of lettuce. Endive may probably never greatly exceed the present somewhat limited demand.

Varieties. There are two distinct types of endive; the Broad-leaved or Batavian type, and the Curled type. There are several good varieties of each suitable for open land cultivation in Britain, such as the *Green Curled Summer*, *Large Curled Ruffec* and *Digswell Prize* of the Curled type, and *Broad-leaved Green* or *Batavian Round* of the Batavian type. The *Broad-leaved Green* is probably the variety most extensively grown in the Home Counties, but the Curled varieties are popular in Cornwall.

Soil. Endive thrives best on a well-drained sandy loam, and a dry sub-soil is to be preferred. The land need not be manured, but a complete fertilizer fairly high in phosphate should be applied at the rate of 500 lb. per acre. The analysis should be approximately 5-10-5. Like lettuce, endive does best on soils possessing a high amount of humus.

Sowing. Endive develops rather slowly, and a long period of growth should be allowed. Crops for marketing in the autumn should be sown in May and June, but for earlier cutting seed may be sown in frames from March onwards, and the seedlings are transplanted. Early sown crops tend to run to seed. For later crops, the seed should be sown thinly like lettuce, in drills 18 in. apart. When the plants are well established they should be thinned to stand at least 12 in. apart in the rows. It is best to thin the seedlings two or three times.

Blanching. The plants are ready for blanching in about three months from the date of sowing. Various methods are employed such as tying up the plants individually or covering them with slates, boards, large flower pots, rough litter or hay. It is useless

to market unblanched endive. The crop should be blanched in batches as once blanched it must be cut and sold.

MARKETING. Endive is marketed in a manner similar to that employed for cabbage lettuce. The heads should be of uniform size and quality.

In general wooden returnable boxes and wooden non-returnable crates are the standard market packages for endive, packs of 24 being most usual.

Radishes. 1. SUMMER RADISHES. Radishes always meet with a keen demand in the spring and early summer months. The production of early radishes is dealt with in Chapter Twelve. The following notes deal with the production of ordinary outdoor crops. As the radish thrives best under cool conditions, it is mostly grown either as a spring or an autumn crop. The crop is very quick growing and under normal conditions can usually be taken in from 4-6 weeks from sowing, if growth is slow the plants do not "bulb" and may run to seed. The Evesham growers make a speciality of the early production of outdoor crops of radishes, using mostly the long type for this work.

Varieties. There is an immense number of types and varieties of radish, but for market only varieties of highest quality should be grown. For outdoor crops varieties of the turnip-rooted, intermediate and long types are used. *Scarlet Globe* is the best of the turnip-rooted, all-scarlet, varieties, while *Sparkler* is of the same type but with a sharply defined white tip. *French Breakfast* is a good intermediate radish with a white tip. *Olive-Shaped Scarlet* is an all-scarlet variety of the same type. *Long Scarlet* and *Wood's Early Frame* are good scarlet varieties of the long type, selling well on the markets as a summer salad.

GENERAL CULTIVATION. The radish likes cool weather conditions and thrives best in a deeply-worked, rich friable soil that contains a high proportion of humus, but will not thrive in an acid soil. The seed of early crops is generally sown broadcast on the bed system. As a rule the beds are made up 6 ft. wide with 2 ft. alleyways between. Later crops are sometimes drilled in rows 12 in. apart, although broadcasting is always practicable.

The seeding rate is about ¾ bushel per acre. For autumn crops sow from mid-August to mid-September.

The seed is sown very early in the Evesham district, where the beds for early crops are usually sown during January and February and then covered with straw for protection. The straw is removed after the seedlings are well up. Batches of seed are usually sown at intervals of 10 days until the middle of May, and again during July and August.

One of the best fertilizers to use is nitro-chalk which also provides lime. This should be raked into the surface soil at the rate of from 200 to 300 lb. per acre. The land should be left firm after sowing as radishes do not "bulb" well on loose soil.

MARKETING. Only young and solid radishes should be marketed. The crop is generally pulled and bunched on the land, but in some districts the bunching is done in packing sheds. The size of the bunches varies, but as a rule open-land radishes are bunched in batches of 12, 15 or 20. Soft "fillis" string is usually employed for tying. The bunches should be washed before they are packed.

Non-returnable wooden crates, such as the lettuce crates or the half-pot box or bushel box make good standard market packages for radishes for long-range marketing.

In order to maintain the demand, radishes should be quickly grown on good soil, and only crops of high, crisp and attractive quality should be marketed. It is a great mistake to market radishes of low quality, i.e. over-sized and hollow produce.

2. WINTER RADISHES. This group of radishes forms firm roots of a larger size and which will keep through the autumn and winter. They find a sale on some markets. The *Black Spanish* (either round-rooted or long-rooted forms of which are obtainable) is the usual variety grown. Sown like winter turnips in June or later the crop comes ready for market from the end of September onwards. It is a useful winter salad crop.

CHAPTER ELEVEN

Miscellaneous Crops

Asparagus. The Asparagus plant, a native of Europe and Asia, is particularly common in parts of Russia where it is used as a forage plant. It is a hardy perennial, and though not truly dioecious usually bears male and female blossoms on separate plants. Actually the plant is polygamous in flowering habit. One of the oldest of our vegetables, asparagus has been cultivated for at least 2,000 years and was highly esteemed by both the Greeks and Romans.

DEMAND. It cannot be said that asparagus meets with an unlimited demand, for it is a vegetable that appears to find favour with a section of the population only, in part perhaps because of its comparatively high cost. London, because of the hotel trade, is definitely the best market for asparagus; but it also sells fairly well in some of the Midland and northern markets. The crop's season is normally from mid-April until mid-June.

SOILS. Asparagus may be grown over a wide range of soils and only very heavy clays appear unsuitable. It thrives quite well on even very light "blowy" sands, but on such requires heavier feeding than on soils of better quality. It is most successful on loams or silty loams, brick earths and black Fen soils, but all should be well drained and free from acidity.

SYSTEM OF CULTIVATION. Although the wide-bed system of cultivation has been the chief method employed in the past, and many acres of commercial plantings of this kind are still maintained, this method of growing asparagus requires much hand labour, and where mechanized production is to be practised the single-row system is definitely the most suitable.

It is probably correct to say that most of the recent plantings of asparagus have been on the single-row system, which undoubtedly has much to commend it under present-day conditions.

VARIETIES. The varieties commonly grown are known as *Conover's Colossal*, *Argenteuil*, *Mary Washington* and *Martha Washington*. The first is said to be of English origin, the second of French, and the last two, which also are resistant to rust disease, are of American. *Mary Washington* is regarded very highly in America and is said to produce the largest percentage of high-grade stalks. There are early and late forms of *Argenteuil* the early form, known as *Early Giant Argenteuil*, giving the large, fine asparagus for which its French markets are famous. Strain is an important factor with this crop and some growers select their own.

RAISING THE PLANTS. It is not desirable to sow the seed where the permanent crop is to be grown as by this method the poor, unprofitable plants cannot be eliminated. It is best to raise plants by sowing the seed in a prepared seed bed in April in drills 15 or 18 in. apart. The seed should be sown thinly, and because it germinates slowly a little radish or kale seed should be mixed with it to mark the rows and enable cleaning to proceed. Soaked seed will germinate more rapidly. The seed bed should be kept free from weeds and the seedlings thinned out to stand 4 in. apart in the rows.

One-year-old, or "maiden", plants are best for establishing new plantations of asparagus, although 2 year old plants may be used. The plants are left in the land until the following March or April and are then lifted with forks and carefully graded. Grading is important as some plants throw up only thin shoots which are of little use for market. An experienced eye can detect these poor plants and all but the strongest and most vigorous should be culled out.*

PLANTING. New plantations of asparagus should be formed either on well-manured land or land in very good heart. The

* It is worth noting that asparagus seed gives rise to approximately equal numbers of male and female plants. Experimental work has shown that the male plants give a yield from 50-60 per cent greater than females, but unfortunately the sexes are not usually declared until the third year of growth.

land should be ploughed and, if necessary, sub-soiled the previous autumn and the manure, if applied, should be then ploughed in.

When planting on the single-row system good deep trenches should be ploughed out 4, 4½ or 5 ft. apart, all being suitable distances according to the type of land, and tillage system used. The trenches can be opened with a double-breasted plough and it should be sent along twice so that the depth ranges from 9 to 12 in. A scuffle should then be set to run along the bottoms of the trenches to loosen the soil. A little of the good top soil is then turned in, on which the crowns are planted. The selected crowns should be set 18 or 20 in. apart in the trenches and covered with 2 or 3 in. of soil only. Each plant should be well firmed. Precautions should be taken to ensure that the plants do not become dry between lifting and replanting. As the plants develop more soil is added to the trenches so that by the end of the season the latter are again level with the surface soil.

Under the bed system three rows of plants are spaced 15 in. apart in beds 5 ft. wide, with 2 ft. alleyways between the beds. These beds are usually laid out by hand and the plants are set in channels chopped out with spades, the soil being turned back from channel to channel as each row is planted. Well-made beds of this kind remain productive for a great many years. Those featured in Fig. 27 are more than 50 years old.

Manuring. In order to maintain the plants in a good producing condition, the beds should receive an application of a complete fertilizer every year, plus single applications of nitrate of soda, or sulphate of ammonia, after the season's cutting is completed. Every two or three years a good application of farmyard manure should be applied to the beds when they are soiled up in the autumn. Although good yields of asparagus may be obtained without manure, provided an adequate amount of complete fertilizer is used, the manure especially on light soils, assists in the maintenance of soil moisture, On heavier land, on the other hand, it tends to keep the surface soil porous and open.

Asparagus in full bearing should receive an annual application of from 1,000 to 1,200 lb. per acre of a complete ferti-

lizer of approximately a 5-10-5 analysis. This fertilizer should be applied when the beds are worked down in the early spring, usually about the month of March. After cutting is finished for the season an application of from 200 to 300 lb. per acre of nitrate of soda or sulphate of ammonia will stimulate growth and strengthen the crowns for the following season's crop. There is no evidence to support the theory that the use of common salt has any outstanding beneficial effect on asparagus although many growers have used it in the past.

Cultivation of the Crop. The routine cultivation of asparagus consists of soiling up in the late autumn and keeping the beds free from weeds. With wide beds the soil is thrown up by spade work, but ploughs can be used for single rows. In the spring much of this soil is pulled down again with light harrows, rotary hoes or hand forks (see Fig. 27). Sufficient soil should, however, always be left on the beds adequately to cover the crowns which tend to rise as the years go on. With single rows the soil is moulded over the crowns each spring with moulding ploughs or specially designed implements, the depth carying according to the type of asparagus grown.

The beds, or rows, as the case may be, must be kept free from weeds. A good amount of hand work is called for in cleaning operations, and small short-handled hoes and "scratchers" of various patterns are often used for the purpose, care being taken not to damage the growths.

Cutting the Crop and Marketing. Asparagus should not be cut until the third year from planting. The cutting should then be a light one, that is, only about half that of the normal season. The shoots are cut with asparagus knives (various patterns), and during warm "growing" weather it may be necessary to go over the beds every day. As the cutting proceeds the shoots are laid together and are later gathered up and taken to the packing shed for grading and bundling. Figs 28 and 29 show this work in progress. The crop is sorted into three grades. Some types of land produce "white" and others "green", and in a few instances, such as in the Wisbech district, both classes are produced on the same farm. Uniformity of size and quality is very essential with asparagus.

English asparagus is usually marketed in bundles of about 2 lb. weight, the circumference being about 10½ in. Specially

constructed wooden or metal boxes are used to hold the bundles firm while two ties of raffia or tape are securely fastened round each. The bases of the bundles are then evenly trimmed and immersed in water for a short time to freshen up the stalks and free the bundles from dirt.

Flat wooden crates (Fig. 30) holding 6, 12, 18 or 24 bundles are the best market packages for asparagus, but the large wicker returnable flats are also used in some districts. Some growers make use of newly-cut "grass" to keep the asparagus fresh in the package, but if the crates are well lined with good moisture-proof paper this precaution is not necessary.

Growing Asparagus Seed. The growth produced after the seasonal cutting is finished will usually mature a crop of seed, and most of the seed commonly offered for sale is a by-product of commercial plantings. The strain can be improved by staking all plants that produce the largest amount of best quality stalks. These should be lifted in the autumn and be replanted on an isolated plot of land, allowing one male to three female plants. The seed produced by these selected plants is then grown on in successive years until a stock is obtained. Improvement in the strain can be effected by saving seed from selected plants but as bees cross-fertilize the blossoms the plants should be well isolated from other asparagus.

The crop of seed should not be harvested until the stalks are quite dead, usually after the growth has been killed by the first frosts. If they are cut prematurely the crowns are likely to suffer. The berries are removed from the stalks by flailing them on a canvas sheet. The berries are then pounded in a tub or vat to loosen the seeds from the pulp. The vessel is filled with water and the contents stirred. If allowed to stand the seeds will sink to the bottom, and the pulp, skins and other debris may be poured off with the water. The seed is then cleaned in fresh water and spread out thinly to dry. The seed is finally cleaned and graded by passing it through a fanning mill. Only large, plump seeds of asparagus should be sown.

Globe Artichokes. This vegetable is more popular on the Continent than in Britain; there is, however, a certain consistent although limited, demand for it, particularly from the London markets, supplying a high-class trade.

This artichoke is produced by a perennial plant which is grown, like rhubarb, as a permanent crop on the same piece of land over a period of years.

SOIL. Globe artichokes thrive best on a deep, fertile loamy soil. The land intended for this crop should be deeply worked and well manured.

Varieties. Two varieties are commonly grown—the *Purple Globe*, which develops a purple tinge when mature, and the *Green Globe*, which develops oval-shaped heads with long, spiny scales.

PROPAGATION. Globe artichokes are propagated by slips or suckers taken from selected established plants in early April. These suckers should be planted 2 ft. apart in rows 4 ft. apart. Some growers plant them in a triangular clump, with a space of 3 ft. between each clump, as this method establishes a productive plantation more quickly than if single plants are used.

CULTIVATION. The plants should be able to produce heads for cutting in the second year, and will continue to produce useful crops for from five to eight years on the same land. The land between the rows should be forked over every winter, and a good application of well-rotted manure turned in. An application of a fertilizer containing phosphates and potash will also assist the plants. This should be applied at the rate of 400 lb. of superphosphate and 150 of muriate of potash per acre in early spring, when the land is hoed for the first time.

MARKETING THE CROP. The artichokes, which are the unopened flower-buds, are best cut in the early morning to preserve their freshness, and are usually cut with about 6 in. of the stalk.

Two or three dozen heads should be carefully packed in non-returnable lettuce crates lined with suitable paper. Blown heads should be discarded, but no worthless heads should be left on to exhaust the plants.

Note.—The globe artichoke is not very hardy, and is apt to suffer injury in hard winters unless protected. Many growers use straw, bracken or other material to protect the plants in

severe weather. The crop is more at home in Southern Euro Globe artichoke seed is very seldom produced under climatic conditions of Britain, and in any event seed is u liable as a means of propagation.

Celery. Celery was not grown as a food plant until a fa recent date. The French appear to have used it first, early the 17th century (1623). It is a biennial plant and is eaten b as a salad and as a cooked vegetable, while it is also canne quantity; all canned celery is used as a cooked vegetable.

The turnip-rooted type, called **Celeriac,** is much liked the Continent, but finding little favour in Britain posses limited market value.

It may be safely stated that the bulk of the output of celery crop is consumed in the raw state as an autumn winter salad, being highly relished by all classes of the pub Its popularity has steadily increased during the last 30 yea In 1918 the area grown in England and Wales was less th 3,000 acres, but the figure rose to nearly 6,000 acres by 19 and to 7,510 acres by 1934.

For several reasons, but principally because of the cro preference for certain types of soil, ordinary celery is not wid grown as a market garden crop, but is restricted to distri where suitable soils are associated with a high water table. Th the crop is mainly grown as a farm crop in the fenland distri of Cambridgeshire, West Suffolk, Hunts and West Norfolk, t "moss-land" districts of Lancashire, and the Isle of Axhol in Lincs. In the last-named district several types of soil ex but all possess the essential character of a high water table, that the crop has the least risk of running short of moisture.

In the Cambridgeshire Fen districts celery is an importa crop, many farmers growing 200-300 acres every year, the cr being dispatched during the busy season in whole train-loa to markets all over the country. Hundreds of tons are al dispatched by road transport.

Types. There are three types of celery, viz., the White, t Pink or Red, and the Self-blanching. Both Red and Wh types are extensively grown for market on the special kinds soil referred to above. A good market celery should devel either medium or large-sized heads of good length possessi

hearts both solid and crisp, with a sweet nutty flavour. Although cultivation and manurial treatment affect the quality of celery, it is very important to choose the varieties most suitable for market. Varieties of celery, however, exhibit a tendency to develop variation and stocks must be constantly re-selected to maintain type.

The Self-blanching type of celery so popular in North America had never been extensively grown for market in this country until recently. Now it is being grown almost everywhere with satisfactory results, especially where irrigation is available, as it is useful for early marketing.

WHITE TYPE. *Curly White*, *Clucas's Special Market White*, *Giant White Solid Curled* are varieties favoured by all the leading market growers, It is on the whole less hardy than some of the other white varieties, and on that account should be marketed first. Its curly foliage imparts to this type a distinctive appearance. *Blundell's White* is also one of the best tall varieties of this type, and is suitable for both early and late crops. Other good varieties of white celery suitable for market are *Wright's Giant White*, *Sutton's Solid White*, *Clucas's Winter White*, *Dobbie's Invincible White*, *Giant Solid White*, *Wareing's Dwarf White*.

RED TYPE. *Clayworth Prize Pink*. This is a favourite market red celery of medium size, but one that develops large solid hearts of good flavour and also matures early. *Leicester Red*, *Covent Garden Red*, *McHattee's Prize Red*, *Clucas's Perfection Pink*, are also all good varieties of medium-sized red celery suitable for the markets.

Wright's Giant Red, *Manchester Giant Red*, *Major Clarke's Solid Red*, *Dobbie's Selected Red*, *Brydon's Prize Red*, are varieties of the large, tall type of red celery popular in the northern markets. The London markets prefer the medium-sized red celery, such as the *Clayworth Pink* and *Covent Garden Red*.

Many growers have developed their own strains of celery that are especially suited to their soil and climatic conditions. Seed is carefully saved every year, a very useful proposition when the time can be spared for the work. It is fair to say, however, that the seedsmen who cater for market growers use every endeavour to build up good strains of celery.

Soils for Celery. Only soils that have a high organ content and are consequently retentive of moisture, such peaty land, or that are associated with a high water table, a suitable for the market production of ordinary celery. The blac Fenland soils of Cambridgeshire are typical celery soils ar produce the earliest crops and also the heaviest yields. On the soils, which are the most easily moved at all seasons, the cele is more readily moulded up for bleaching. Black-land cele also washes very well, and is especially suitable for crating. O the other hand, the loamy soils produce celery of better qualit the heads being usually both crisp and sweeter, and possessi better keeping qualities. It is nevertheless true, however, th the bulk of the celery crop will always be grown on the Fenlan soils and other peaty soils of a similar character. In the ye 1936 the celery acreage totalling 7,495 acres, was distribute as follows :—

Peaty Soils.		*Silt and Loamy Soils.*	
	Acres		*Acr*
Cambs.	2,952	Lincs.	9
Hunts.	840	Yorks.	1
Norfolk	543	Notts.	2
Lancs.	1,025	Other areas	2
Other areas ...	394		
Total	5,754	Total	1,74

Raising the Plants. The work of raising the plants for large acreage of celery is a big undertaking. For this reaso many growers have their plants raised by specialist plan growers who operate in the vicinity of the large celery growin districts. Frames, Dutch lights and glasshouses are used fo raising the seedlings. Most of the plant growers mainly us warm frames and propagating pits, though cold frames ar also used for raising later batches of plants. The warm frame are obtained by using bottom warmth derived from a gentl hot-bed of stable manure. The seed should not be sown unt the heat is declining. On the whole the plants are better if grow under fairly cool conditions, the seedlings so raised receivin less check when bedded out in the open. The seed can be sow from the middle of February onwards, and the seedlings fro these sowings are usually ready for "bedding out" in Apru

according to weather conditions. The earliest batches of seedlings are transferred as soon as large enough, when they have a pair of true leaves, to cold frames such as a series of Dutch lights. Later batches are transferred to outdoor beds. Actually the cooler the conditions under which celery plants are raised the better it is for the crop's prospects. If it is found that insufficient seed was sown, or if the seed fails, fresh batches of seedlings may be raised quickly in heated glasshouses.

All soil used for raising celery seedlings should be sterilized and the old soil should never be used again for the same purpose. Unless known to be "clean" the seed should also be disinfected to kill the spores of *Septoria* (blight), a solution of formalin being the best sterilizing medium for both the seed and the soil. Expert plant growers "chit" the seed sometimes before sowing it in cold frames, as "chitted" seed is quicker in coming up and is less likely to rot in the cold soil. "Chitting" is accomplished by mixing each 2 oz. of seed with about one-quarter its bulk of fine sifted sand. The mixture is then soaked and placed in pans or boxes in a moist atmosphere, and a temperature of about 70°F., until the seeds are just sprouting. The seed is then sown evenly in the seed bed and lightly covered with sifted soil. One ounce of seed, which should produce from 20,000 to 25,000 plants, should be allowed for each acre of land—actually there are roughly 60,000 seeds to the ounce. About 21,000 plants are required to plant one acre of land. Fig. 33 shows the celery seedling beds on a large Cambridgeshire plant nursery.

The plants are "bedded" (pricked) out by women and girls who usually do the work at a fixed rate per thousand. The beds are made on a piece of well-prepared land and are usually 5 or 6 ft. wide with narrow footways dividing them. The "bedding" out is an important point in raising celery plants, as it breaks the plant's natural tap-root and encourages the production of a good root system. The seedlings are spaced about 2 in. apart each way in the beds.

Place of Celery in Crop Rotation. On most farms the celery crop is regarded as a good preparation for potatoes, which usually follow celery. Preceding crops are generally corn (if grown) or sugar beet, the land being well ploughed

and left ready for the celery as soon as the crops are off in the previous autumn.

MANURING. Manure is not always applied on the fen soils, much depending on the land's condition and quality. On loamy soils manure is always applied, the usual rate being from 20 to 30 tons per acre of well-rotted farmyard or stable manure, which is applied in the furrows where the rows of celery are to go. Peaty soils contain much organic matter, and thorough ploughing and cultivating, together with the use of a high-analysis complete fertilizer, may be sufficient treatment to secure a good crop of celery. Large quantities of commercial fertilizers are usually applied on the black fen soils for the celery crop.

Phosphoric acid is an important nutrient for celery, and where farmyard manure is used a good application, 5-6 cwt. per acre, of superphosphate should always be given. Where no manure is applied the land should receive from 1,000 to 1,5000 lb. per acre of a complete fertilizer with an analysis approximating 4-10-6. Thus to obtain 1,200 lb. of a fertilizer mixture of this description if mixed on the farm, one may use :—

240 lb. sulphate of ammonia	=N. 48 lb.
800 lb. superphosphate (18%)	$=P_2O_5$. 128 lb.
150 lb. muriate of potash	=K. 75 lb.
10 lb. dry filler (earth or sand)	
1200 lb.	Approximate analysis 4-10-6

The above mixture is suitable as a general application for fen and other peaty soils. For loamy soils, as a general recommendation, a mixture possessing approximately a 5-10-5 analysis should be used on the basis of 1,000 lb. per acre with farmyard manure and 1,500 lb. without manure. It cannot be denied that the best crops of celery are grown by means of a judicious combination of both manure and fertilizer. The method of applying the fertilizer varies ; some growers put it on at the time of preliminary cultivations and others distribute it down the furrows that are opened up to receive the dung, the fertilizer going on top of the dung, before the soil is turned back. If no manure is applied it is usual to apply the fertilizer with a distributor when the land is cultivated.

PREPARATION OF THE LAND. Much of the celery grown is planted by hand, but mechanical transplanters are also used and

are giving satisfaction. The land for celery is prepared for planting with the aid of cultivators, drag harrows and the corrugated roller. At the time of planting the harrows are sent over again and the land is finally marked out with a marker for the celery rows, which are usually 5 or 5½ ft. apart on average soils. Field celery is always planted on the "flat" the hand planting being done by skilled men on a "piece-work" basis. The plants are delivered to the planters by women or girls who drop them about 4½ in. apart (8 to the yard), and roughly 21,000 plants are required to plant an acre, but it is safest to allow 22,000. Planting is usually carried out in June; if the weather is very dry the plants must be watered in.

Crop Cultivations. The land between the rows of celery is frequently cultivated to kill weeds, and hand-weeding of the rows of plants is done when necessary. On some types of soil a top dressing of from 200 to 300 lb. of sulphate of ammonia or nitrate of soda will be beneficial, but the applications of nitrogen should be judiciously applied as excessive amounts encourage the production of "pithy" celery.

Blanching the Crop. Blanching, or etiolation, is an important operation. As the celery develops the soil is banked up to the rows, first with a digger-plough and later with specially constructed celery moulders, which are so fashioned that the soil is banked up close to the plants. On peaty soils the moulding-up work is more easily performed than on loamy soils where some hand-work with spades may be required to finish off the work so that the celery is well blanched. Methods of moulding up celery vary according to the locality, and the implements employed vary in design.

Lifting and Marketing the Crop. The earliest crops of celery are lifted from the end of August onwards. Digging and bundling is performed by gangs on the piece-work basis, or if the crop is to be crated the celery is lifted and carted to a washing shed where the trimming, washing, and crating are carried out. A good amount of celery is now crated for market, but much of the crop is sent to market in an unwashed condition for sale to the celery washers in the large towns and cities. Whatever system of marketing is adopted the crop should be carefully graded according to size and quality. If bundled for dispatch the celery should be graded into two sizes. Twelve

graded heads of celery make a market bundle, and the practice of putting small heads in the centre of the bundle is both unreasonable and unwise, and should be discouraged. If it is crated the celery should be sorted into selected sizes after washing, so that crates of 12, 18 and 24 heads are marketed. Crated celery should be carefully trimmed as to length, and discoloured, cracked or diseased outside stalks should be removed.

Celery is one of the most expensive crops to grow and market. The cost of producing an acre of celery was estimated to be between £30 and £40 in 1934. Where washing and crating was done the expenses of marketing were at least 6d. per crate, not including the normal market charges. The cost to-day would be much higher.

Self-blanching Celery. This type of celery, which did not appear until late in the 19th century, is now extensively grown in districts where soil conditions are less suitable for the green type. It is the most suitable type of celery for early marketing and is less hardy than the other types of celery. No earthing-up is required, but some additional blanching can be secured by the use of boards. It is possible to grow this celery on light types of soil especially with the aid of irrigation. As it comes in rather earlier than the green type it usually finds a good market. The Doré celery of the French, *Celeri doré ameloire*, is a somewhat similar type, suitable for frame cultivation.

Land for self-blanching celery should be firm and well-worked with cultivators. A light dressing of peat is useful to the crop, serving to hold moisture, and should be cultivated into the surface. A well-made compost may also be used similarly. Following this an application of from 4-6 cwt. per acre of hoof and horn meal, which should also we well-worked into the soil should also be given.

Varieties. The variety generally grown is *Golden Self-Blanching*, of which there are two strains; one about 6 in. taller than the other and more vigorous (there is a form with rose-tinted ribs on the outer stems), and this seems to be the same as the *Paris Golden Self-Blanching*, described by Vilmorin as having been introduced by them in 1883.

Raising of Plants. To obtain an early start seed is sown under glass or in warm frames in March and the plants are

pricked off in boxes. Later sowings may be made thinly under Dutch lights or in French frames on gentle bottom heat, and the plants are transferred without an intermediate pricking off. It should not be sown earlier than March as there is a risk of bolting with earlier-sown crops.

PLANTING. The plants are put out in the open land after hardening, and are set quite closely, *e.g.* 9 in. apart in the rows and the same distance between the rows so that the crop makes almost a solid mass of growth when fully grown. Celery so grown will need no further blanching, but if set in rows wider apart blanching with boards will be necessary. A gangway 18 in. wide should be left every 7 or 8 rows to provide access to the plant from either side. The crop is also grown in wide-spaced rows.

Cleaning the land and overhead watering from irrigation spray lines or rotary rainers are given as required, together with one or two light top dressings of a complete fertilizer mixture, or a mixture of nitrate of soda and muriate of potash.Potash should not be omitted as it will impart quality.

MARKETING. Self-blanching celery is usually damaged by even slight frosts so should be cleared from the land by October. Two grades are usualiy made of the heads—first and seconds—the market unit being a dozen heads, trimmed lightly, and either tied or dispatched loose. It is also marketed in crates.

Growing Seed of Celery. The production of celery seed involves a period of roughly 18 months. Plants raised from seed sown in April or May are planted out during June and July. To avoid the production of superfluous, sappy growth, which is apt to be killed during the succeeding winter, the land for this seed crop should not be over-supplied with nitrogen. Land that has been cropped with early potatoes that received manure does very well for the purpose.

A week before the land is planted it should receive an application of 400 lb. of a 0-12-5 fertilizer per acre. The plants should be set out in rows 24 in. apart with a space of 12 in. between the plants. At this rate roughly 22,000 plants will be required to plant an acre. During the ensuing winter the plants may need some protection if the weather becomes severe ; straw is often used.

During both the first and second years' growth great care should be taken to prevent the plants becoming infected with leaf-spot (*Septoria* spp.), as this disease is capable of infecting the seed. At intervals of a fortnight or three weeks the whole crop should be carefully and thoroughly sprayed with Bordeaux or Burgundy mixture and a sharp watch for traces of the disease should always be maintained.

Celery is a crop that remains fairly true to type, but all seed crops should be watched for the appearance of rogues ; the best time is when the plants are fully developed.

The crop is usually ready for harvesting by September. As soon as it is dry enough it should be removed from the field to complete the drying process under cover, otherwise rainy or damp weather may set up attacks of mildew. If perfectly dry in the field it can be stacked under cover, but if not the crop should be spread out thinly in a shed or greenhouse. Celery seed cannot be successfully flailed out until the "straw" is perfectly dry. The yield of seed ranges from 500 to 600 lb. per acre.

Rhubarb. Rhubarb is grown for its leaf stalks, which are used for stewing, pies, jam, etc., and not being a fruit is classed as a vegetable. The plant, a native of Siberia, is a hardy perennial, and when once established will continue to yield a crop for many years on the same land. It thrives best under cool conditions, and does extraordinarily well in some districts, particularly the Leeds district of Yorkshire. Although its seed is saved and sold rhubarb does not come very true to type from seed, so vegetative propagation is universally practised by market growers.

Varieties. The four most important varieties of rhubarb for commercial growers are *Hawke's Champagne*, *Linnaeus*, *Prince Albert* and *Victoria*. Champagne is a fairly large, well-coloured early variety; Linnaeus is a second early and also highly coloured; Prince Albert is also an early variety with longer and thicker stalks; and Victoria is considered to be a later variety producing very large, well-coloured stalks. Another variety worthy of mention is *Dawe's Champion*, which develops an excellent colour when forced. *Prince Albert*, *Linnaeus* and *Dawe's Champion* are the best forcing varieties, while *Champagne* is an excellent variety for general culture, and popular

in Bedford and other market growing districts, *The Sutton* is a rhubarb of excellent quality both for ordinary culture and for forcing.

CULTURE. Rhubarb cultivation is divided into two sections : (1) Natural, or out-door, rhubarb, and (2) forced rhubarb. The latter may be regarded as a specialized production, and so is dealt with in the chapter on forced vegetables. The following details relate to out-door cultivation only.

SOILS. Sandy loam soils of good depth are the best for out-door rhubarb, as these warm up quickly in the spring and promote early growth, which is most profitable.

PREPARATION. As a well-managed field of rhubarb will last for upwards of 10 years in a good bearing condition, the preparation of the land should be thorough. The land should be ploughed and subsoiled in winter, and at the same time a good application of farmyard manure, up to 30 tons per acre, should be ploughed under. Before planting, from 4 to 6 cwt. of superphosphate per acre should be applied and well harrowed in.

PROPAGATION AND PLANTING. Good clumps from established plantations should be selected for propagation. Worn-out clumps should be avoided, and propagation should be from vigorous plants in full bearing condition. The yields may be much improved by a clonal method of propagation. The clumps should be dug in March and divided into ''sets'', each possessing one good bud and a piece of root. The sets are planted either 3 ft. or 4 ft. apart each way, according to the variety. The *Champagne* and *Linnaeus* varieties are satisfactory at 3 ft. each way (4,840 plants to the acre), while *Prince Albert* and *Victoria* are better at 4 ft. (2,722 plants to the acre). Where mechanical cultivation is used, the rows may be spaced from 4-5 ft. apart, with the plants 30 in. apart, with good results. It is also a good plan to leave land unplanted to serve as cartways at convenient intervals. This will obviate the drawing of carts through the rows of plants when supplying manure.

The sets are planted either with a spade or laid in ploughed-out furrows at a depth that leaves the bud level with the surface of the soil. The sets should be made firm by treading.

CULTIVATION. Clean cultivation should be maintained at all times, or perennial weeds such as couch grass and thistles may soon become established and choke the crop beyond recovery—and this is the chief reason why land that was summer fallowed is the best with which to start the crop.

FERTILIZERS. As rhubarb is a gross feeding plant the land should be heavily manured. The constant pulling of the crop will soon exhaust the clumps unless an adequate supply of plant nutrients is maintained. The crop always responds to nitrogenous substances, especially after the season's pulling is completed. The land between the plants should be manured when it is ploughed, or dug, in the autumn, and in January, from 800 to 1,000 lb. per acre of a complete fertilizer, possessing a 1-2-1 nutrient ratio, should be well worked into the top soil. About mid-way through the pulling season, from 200 to 250 lb. per acre of nitrate of soda or sulphate of ammonia should be applied, and after pulling is finished for the season, this stimulating application should be repeated as it assists to build up the crowns for the next season's crop.

MANAGEMENT. Early cropping can be induced by covering the crowns in January with long stable litter or other strawy material. In some parts of the country the practice of covering a portion of the clumps with forcing pots, boxes, etc., to obtain early pullings, is still followed. The crop should not be pulled the first year following the planting, and only a light pulling should be taken during the second year. Although fields have been known to last in a good bearing condition for upwards of 12 years, they will usually be nearing exhaustion after 6 or 7 years of cropping, according to the quality of the land. Rhubarb growers should always plant a few acres every year, to ensure a succession of fields in good condition.

The clumps usually throw up flowering stalks during April; these should be chopped off about a foot above ground to prevent exhaustion of the plants by seeding.

MARKETING. Outdoor, or natural, rhubarb is pulled and tied in bundles. The earliest pullings are bundled with the small leaves intact, but with later pullings, when the leaves are large, the sticks are trimmed down, leaving only a few inches of leaf. Still later in the season the leaf may be entirely removed.

The size of the bundles varies considerably. London market bundles weigh from 2 to 3 lb. during the early part of the season, and twice that weight or even more later on. There is not actual standardization, and the new grower should find out what his different markets prefer. Some markets have developed a trade for loose rhubarb, as retailers are then free to make up bundles to suit their purpose.

Returnable wooden crates and boxes are much used for the short-distance marketing of rhubarb, but the non-returnable rhubarb crate with dimensions of 28 x 11¾ x 7⅛ in. is a useful package for long-distance marketing.

Vegetable Marrows. Vegetable marrows being popular among all classes usually meet with a good demand. The best prices, however, are realized for early marrows, and the grower must contrive to obtain this crop as early as possible in the season. It should be noted, also, that the market requires young, tender marrows and not coarse, over-grown specimens. They are types varieties of *Cucurbita pepo* and *C. moschata*, the one being a bush plant and the other a trailer.

Varieties. The various types of vegetable marrow are the only members of the Gourd group widely cultivated in Britain. Either the bush or trailing types are grown for market, each district having its own particular preference. The trailing types are popular in the north, while the bush types are preferred in the south and in the Midlands. The *Wallasey Cream* is a favourite variety in the Cheshire district, and the round, smooth cream-coloured *Pen-y-Byd* is also grown to some extent in the West of England. The following are recommended as commercial varieties :—*Clucas's Roller* (a fine white, trailing variety), *Long Green Trailing*, *Long White Trailing*, *Long Green Bush*, *Long White Bush*, *Wallasey Cream*, *Moore's Cream*, *Pen-y-Byd*.

As in other members of the Gourd group, different flowers of each sex are borne on the same plant. Some growers hold that it is worth while to go over the plants in the early morning and pollinate the female flowers with male blossoms.

Land Preparation and Manuring. Marrows should be grown on well-prepared and manured land. Sandy loams are the best soils for early crops, as they are warmer. Early plough-

ing is essential, and a good dressing of farmyard manure should be ploughed under at the same time. The plants will last longer in a bearing condition and withstand drought better if the lighter types of land receive a generous application of manure, say up to 20 tons per acre. Inorganic fertilizers should not be applied to the seed-bed, as the seed and seedlings are susceptible to injury from these substances.

Raising the Plants. The earliest crops of marrows are grown from plants raised under glass or in frames, and planted out in late May. It is always a risky proceeding, however, and either cloches or the Evesham hand-light might well be used to make sure that there will be no loss from frost. The method of growing early cauliflowers and early marrows on the same field in juxtaposition, making use of the Evesham hand-light for both crops in succession can be recommended (see Fig. 40). This aspect of the subject is dealt with in Chapter Twelve.

Open land crops of marrows are grown by sowing the seed about the third week in May, where the plants are to stand. The rows of plants should be 4 ft. apart for the bush types, and 5 or 6 ft. apart for the trailing types. A space of at least 3 ft. should be allowed between the plants in the rows. Good distances for marrows are 4 ft. apart each way for bush types and 6 ft. for the trailing types. When sowing, three seeds should be sown in the form of a triangle 2 in. apart, to make sure of obtaining a good strong plant at each "hill".

A moderate application of a complete fertilizer will be very beneficial to the growing plants. A mixture composed of 150 lb. of sulphate of ammonia, 400 lb. of superphosphate and 100 lb. of muriate of potash should be applied between the rows and hoed in.

Cultivation. Surface cultivation should be continued as long as it is possible to get between the plants without damage. It is a crop that suffers badly from drought, so that overhead irrigation is worth using in dry periods. Towards the end of the summer the plants are usually attacked by Mildew. This can be warded off to some extent by the use of finely-divided sulphur as a dust.

Cutting and Marketing. Marrows are usually cut by being wrung off the plants so as to avoid loss of sap by bleeding. The

fruits should be gathered at least three times weekly. Counts of 12, 18 and 24 fruits, according to size, are usually packed in wooden crates, with a little hay or grass for packing. When they become cheaper later in the season marrows are often carted away loose, or packed in sacks and returnable packages, such as wicker "pots" and wooden boxes. As a rule only one grade is made, but some markets require larger marrows than others, and high-class trade requires only small marrows. Three grades, viz., large, medium and small, can therefore be made if occasion demands. It should be borne in mind that it weakens the plants to allow the fruits to develop to a large size.

Growing Seed of Vegetable Marrows. Selected fruits from good high-cropping plants may be left to develop until fully mature. The fruits are then removed, cut in half, and the seed and pulp can be scooped out with a spoon. If placed in a tub of water and churned up with a stake, the seed can be separated from the pulp. It will, however, separate better if the pulp is left to ferment for a day or two before washing out the seed. The seed is finally washed clean in a box sieve, using flowing water, and dried.

Other Gourds. The popular pie pumpkin and the squashes of America (in the U.S.A. our marrows are classed as pumpkins), have made slow progress with the British public. Pumpkins for pies, however, are meeting with an increasing demand The best variety for this trade, as it keeps in good condition for several months, is the *Large Yellow*. The squash is a distinct species, *Cucurbita maxima*, and is a trailing plant. One of the best varieties of squash is the *Hubbard*. Both pumpkins and squashes are grown by methods similar to those for vegetable marrows.

Spinach. Despite the fact that it is regarded as a vegetable of outstanding value from the standpoint of health-giving properties, spinach is not a crop of major importance. In the United States, however, spinach ranks as one of the leading crops amongst the vegetables grown for human food. One pronounced draw-back is that being a crop that thrives best under relatively cool conditions it is not adapted for cultivation in hot dry weather. Under such conditions it quickly runs to seed.

Early-summer and autumn-sown crops are, however, usually successful under our conditions, while summer crops may be speculative.

VARIETIES. There are four types of spinach, each adapted for growing at different seasons :—

(1) The *Savoy Leafed* or *Bloomsdale*—an early, productive round-seeded variety with leaves large, broad and crumpled like those of the Savoy cabbage. The plant stands upright and is rather apt to run quickly to seed. This type is useful for early spring-sown crops.

(2) The *Round Leaved* or *Summer Spinach*—the best round-seeded type for summer cultivation. There are varieties possessing especially long-standing properties : *Victoria*, *Broad-leaved Flanders*, *Long-standing* or *Rueil Long-standing* are good varieties of this type suitable for market growing.

(3) *The Giant Thick-leaved*—also a round-seeded type, producing very large, dark green, fleshy leaves. This type is popular with the canners, as it produces a heavy tonnage and stands processing well. *Giant Viroflay* and *Giant Thick-leaved* are good varieties.

(4) *Prickly-Seeded Winter*—the type used for sowing in the autumn to stand the winter. Good varieties of this type are known : *Giant Thick-leaved Prickly*, *Broad-leaved Prickly*, *Long-standing Prickly*, *Giant Winter*, etc.

SOIL. Spinach thrives best on deep sandy loams, or silt loams, that are free from acidity. An ample supply of humus, which holds moisture, is a great aid to the production of successful crops of spinach. Lime should be applied if required, as spinach will not thrive in sour soil.

PREPARATION. For summer crops the land should be ploughed early and deeply. The spinach crop does best on well-settled land. It is really better to grow spinach on land that was well manured for a previous crop and rely on the application of a good fertilizer mixture for the immediate availability of plant nutrients. If the land selected for the crop is not in good heart, a moderate application of manure, plus fertilizer mixture, should be given. A 4-8-4 fertilizer appears to meet the requirements of

spinach under average conditions. Where no manure is used, from 800 to 1,000 lb. per acre of such a mixture should be applied. If from 10 to 12 tons of manure per acre are ploughed under, 500 lb. per acre of the fertilizer should suffice to produce good results. It is important to remember that spinach makes rapid growth, therefore the availability of plant nutrients is an important factor in production. This crop responds to irrigation.

Sowing. Crops of early summer spinach should be sown from March onwards. The rows should be drilled 18 in. apart, and the plants should be thinned out to stand 4 in. to 6 in. apart in the rows. Use one of the round-seeded varieties for these crops. Seeding is usually at the rate of 20 lb. per acre. It is a good plan to soak the seed for 24 hours before sowing.

Crops for the autumn and to stand the winter should be sown from about the middle of August until mid-October, using one of the prickly-seeded varieties for the later crops to stand over. September is a good month under English conditions for sowing winter spinach.

Marketing the Crop. With crops of summer spinach it is customary to pull the plants from the ground or cut the tap root just below the surface of the soil, so clearing the land of the crop. On a large-scale long-handled cutting tools are used for the job. Plants running to seed should be discarded. It is usual to rinse the spinach in water before it is dispatched, to remove dirt and grit. The wooden bushel box, which holds about 12 lb. of spinach, is a useful market package. Spinach should be packed loosely and not rammed tight in the packages.

As for winter spinach, it is customary to pick the larger leaves as they develop. The leaves should be pulled sideways and outwards to avoid damage to the plants.

Canners take large quantities of this crop as it processes well.

Saving Spinach Seed. In the spinach plant the male and female flowers are usually on separate plants, although strains having a number of plants bearing flowers of both sexes are sometimes encountered. It is a point of interest that the female plants form larger rosettes of leaves than the male, and are therefore more productive. When saving seed, any male plants of a spindly, non-leafy character should be pulled up, as plants of this nature are undesirable as pollinators.

As a rule, crops of summer spinach sown early will mat a crop of seed. Over-wintering crops of prickly spinach also mature a crop in a normal season. Crops of seed may treated in the same way as beetroot and mangold, spinach be of the same family (*Chenopodiaceae*), as these crops.

New Zealand Spinach. This spinach, a distinct plant fr the ordinary spinach, *Tetragonia expansa*, is grown to a sm extent for market; it is encountered more frequently in retail shops that are served direct by small growers. This crop sho be grown under conditions similar to those advised for other types of spinach, but the seed, each of which is in a h case or pod, is best sown in boxes or pots under glass, put out the plants in the open during May. The advantage of plant is that it thrives under adverse weather conditions a does not run to seed quickly in hot weather. As it covers ground very rapidly when once established it should be plan not closer than 3 ft. apart each way. The leaves and you shoots are gathered as required. It is a useful spinach for "ho types of soil where the other kinds do not thrive so well.

Leaf Beet or Spinach Beet. This plant is also grown to limited extent as a market crop, and the same can be said its related plant, the Swiss Chard or Seakale Beet. There very little inquiry from the markets for this class of spina although the shops will take it when other kinds of spinach short. Swiss Chard or Seakale Beet, is occasionally seen in London markets, mostly as imported produce, but the dema is limited. These crops possess little value for the grower w supplies markets but are worth attention by those with a sh trade. Chard forms a substitute for seakale.

Crops of Chard are grown in rows 18 in. or 24 in. apart wi the plants spaced by thinning the seedlings 10 or 12 in. apart the rows. The crop also transplants quite well and so may started in frames or under glass.

Varieties. *Lucullus*, *White Lyon* and *Green-leafed* are usual grown and these develop the large white leaf ribs valued as substitute for Seakale. Chard is fairly hardy and with sor protection will stand through average winter.

Marketing. It is customary to gather the individual leaves Chard as they mature. They are bunched and packed carefull

Mushrooms. The production of mushrooms under cultivated conditions has been a feature of commercial horticulture over a long period of time.

The cultivated mushrooms are varieties of the wild mushroom of European fields *Psalliota* (*Agaricus*) *campestris*; the two most commonly grown are the Brown and the White, but occasionally a Cream variety is encountered. The white variety is definitely the most popular with the purchasing public, but the restaurants and hotels maintain a demand for the brown variety.

In by-gone days mushrooms were grown in old pits, disused quarries and tunnels, and also beneath railway arches, besides out of doors during the summer months. In recent years, however, the industry has adopted more scientific methods, and properly constructed mushroom sheds are used on all up-to-date establishments. The crop may also be grown successfully in glasshouses provided effective method of darkening is used. All properly constructed sheds should be heated with hot water or steam pipes, so that a suitable temperature can be maintained at all seasons of the year.

Sterilized or Pure-culture Spawn. The old method of making mushroom spawn, the "brick system", has now largely given way to methods that follow scientific lines. Cartons containing one quart of vigorous spawn grown in sterilized media that can be relied on to give satisfactory results, are now on the market, and this source of spawn is now almost exclusively used by all modern growers. Spawn making should not be attempted by the grower; it should be purchased from specialists.

Brick Spawn. This type of spawn, if made by sound methods, and fresh, can still be used successfully. It should be purchased from specialists.

Manure The most important points in the successful cultivation of mushrooms are (1) choice of manure, and (2) its correct treatment. The manure should, if possible, be obtained from well-worked and well-fed horses such as racing or military stables, or other establishments where healthy animals, carefully fed with hay and grain and bedded with pure wheat straw, are kept. Manure from stables where the horses are fed with

green fodder or carrots, or where peat moss or sawdust are used as litter, or where disinfectants and other chemicals are freely used, is unsuitable for mushrooms. The manure should contain plenty of long straw litter well impregnated with urine, but if the material is on the dry side water may be used to moisten it.

In the summer months the manure may be stacked in the open for composting, but at other periods of the year it should be kept under a Dutch-barn type of shed, or a simple lean-to shed with open sides may be used. The art of turning the raw manure into suitable compost is the chief feature of the routine of mushroom growing. When the manure arrives (all the manure for each fresh set of beds should if possible be secured within the space of a week), it should be stacked in a square or rectangular heap with vertical sides. As it is stacked water may be applied if required and ground gypsum at the rate of 28 lb. per ton is sprinkled on the layers of manure to prevent "greasiness". At the end of about 6 days the temperature of the heap will have risen to a point between 140° and 160°F., and the whole heap should then be turned, working the outsides into the centre and well shaking each fork-full as the work proceeds. From three to six turnings at intervals of 4 and 3 days, i.e. twice a week, will be necessary before the material assumes the dark brown, partially rotted, condition required before the bed are made up. This work may take from 2 to 3 weeks, according to the quality and state of the original manure. The operator must watch for signs of burning (this produces a greyish condition), and excessive dryness, which can be corrected by the judicious application of water, and for greasiness, which can be corrected by adding more gypsum.

When ready for making into beds, the compost should be of a deep brown colour throughout, hot and steaming, but any disagreeable odour should have disappeared. It should be sufficiently moist to bind together when squeezed into a ball, and leaving the hand slightly moist. The straw should be short but not broken down into small fragments, otherwise the beds become too solid and the spawn will not "run" freely. It requires both skill and experience to become a successful compost maker, which is one of the reasons why specialist mushroom growers are usually employed on large establishments.

MAKING THE BEDS. Two types of beds—flat beds and ridge beds—are generally used, but for out-door cultivation ridge beds are the more suitable. Flat beds are normally made about 12 in. thick in the winter, and about 9 in. thick in the summer months. If artificial heating is employed, a thickness of 9 in. is sufficient. Ridge beds are normally made about 2 ft. 6 in. wide, 2 ft. 6 in. high, tapering to a width of 6 in. at the apex.

After the prepared compost is made into beds, the temperature of the material usually rises to a fairly high point, often as high as 140° F., but within a space of from 7 to 10 days it will gradually fall to 80° or 75° F. When steadily below 75° F., the beds may be safely spawned, 70°F. is a good temperature for spawning the beds. Spawning consists of inserting pieces of spawn, either brick or pure-culture, the size of a hen's egg if from a brick or a walnut if from pure-culture, evenly spaced about 9 in. apart each way just beneath the surface and pressed firmly into contact with the compost.

After spawning, if out-doors, the beds should be covered with long litter, but under cover this is not necessary. The shed temperature should be maintained between 50° and 60° F., with a slight amount of humidity. The atmosphere of the shed should never feel dry.

CASING THE BEDS. The spawn should commence to "run" in from 8 to 12 days. The "run" has commenced when the compost in contact with the pieces of spawn assumes a bluish mouldy appearance. Casing consists of covering the beds with about 1 in. of either "second spit" or sterilized soil of a loamy character mixed with a little fresh lime. The soil should be just moist enough to hold together, but not so wet as to have a pasted effect when in position. The casing soil should not be beaten or pasted down and on indoor flat beds may be loose and friable. After casing, all out-door beds should be covered with a thick layer of straw, but this is unnecessary for beds in sheds.

VENTILATION. Plenty of fresh air should always be admitted to mushroom sheds, but draughts should be avoided. A slight amount of humidity is beneficial, and usually secured by damping the beds and pathways with a fine misty spray as required. Shed temperature should be between 55° and 60° F., and kept constant.

Pest Control. The troublesome mushroom flies must be controlled by fumigation or by dusting or spraying. DDT has proved an effective insecticide for these pests.

Cropping. The first mushrooms usually appear in from 8 to 10 weeks, although under very favourable conditions they have been known to appear in 6 weeks or even a month. Good beds should continue to bear for a period of 3 or 4 months, but the crop usually appears in periodical "flushes".

A fair crop is said to be from 1 to 2 lb. per sq. ft. of bed, but this is often exceeded. One ton of good manure should make up about 40 sq. ft. of bed 9 in. thick.

Final Recommendations. No other branch of commercial horticulture demands such close attention to detail as mushroom growing. Thorough cleanliness, the use of first-class materials only, and the use of suitable structures are all points of importance. After each crop is finished the sheds should be thoroughly cleansed by burning sulphur at the rate of 2 lb. per 1,000 cub. ft., both before and after the beds are removed. The floors and walls of the sheds should also be sprayed thoroughly with a 2 per cent solution of formaldehyde, and the sheds kept closed for 24 hours afterwards.

Marketing. The mushrooms are pulled out, not cut, which is done by holding the cup and pulling with a slight twist. The stem is afterwards cut away close to the cup.

It is usual to make three grades, viz., buttons, cups and broilers, each being a different stage of development. Chip baskets of either 6 or 12 lb. are excellent packages for mushrooms. Blue or white tissue paper is used for lining. Normally about 4 lb. weight of mushrooms are packed, gills downwards, in the 6-lb. chip, and 6 lb. in the 12-lb. chip. If gritty the mushrooms should be dusted lightly with a soft brush. Each basket should have a cover either of cardboard or other suitable material.

Sweet Corn (Corn Cobs). With a developing market in Great Britain for this vegetable, which is so popular in America, the crop is now being grown commercially, and satisfactory prices are obtained for well-grown corn cobs of the correct type. Although sweet corn thrives in a high temperature during the

growing season, with plenty of sunshine, it can be grown successfully in the South and West of England. Over 500,000 acres are grown annually in the U.S.A.

Sweet Corn is a type of maize, *Zea mais*, and many varieties are known. Varieties suitable for English conditions are limited, and while few can be recommended with confidence the following have given good results, *Extra Early Bantam*, *Buttercup*, *Early Golden Market*, *Golden Cross Bantam*, *Dorinny*, *Canada Gold*, *Country Gentleman*, *Golden Bantam* and the *John Innes Hybrids*. The variety *Golden Standard* is not strictly of the sweet corn type but is hardy and suitable for English conditions, and the cobs are quite sweet and palatable when green. Experimental work has shown that the hybrid sweet corns are more vigorous and more productive than ordinary varieties. These hybrids are the product of *first crosses* of diverse parents (*Golden Cross Bantam* is one); the seed has to be specially grown and is usually obtained from seedsmen who re-make the cross each year to maintain supplies. (See page 92 for description of how the hybrids are raised in England).

The best crops are grown on deep, warm loamy soils which may be either manured or treated with a complete fertilizer. If manure is given an additional amount of phosphate, say 400 lb. of superphosphate per acre, should be applied before sowing or planting. If a complete fertilizer is used, satisfactory treatment would be 600 lb. per acre of a 4-12-4 or 5-10-5 mixture.

As the maize plant bears both male and female inflorescences, and the latter are wind pollinated, the crop should be grown in blocks and not in long roca. The rows should be 2 ft.- 2 ft. 6 ins. apart and the plants 12 in.-18 in. apart in the rows. The plants vary considerably in size according to variety. The hill method of planting is also used, about four plants to the hill which are plotted on the square or rectangular line out.

Seed may be sown in the open ground about mid-May, two to four seeds being inserted together 1½ in. to 2 in. deep to make sure of an even plant. Surplus plants should be pulled out. To gain time in this country many growers sow seed in pots or boxes under glass in late March or early April transplanting the plants to the open land in late May or early June. The crop is easily damaged by low temperature and nothing is gained by

early sowing or planting. Cloches may be used to protect early sowings.

Seed varies in size and requirements will run from 6-10 lb. per acre according to variety and planting distances.

The crop should be kept clean and frequent but shallow cultivations are beneficial. The plant is shallow rooting.

Cropping commences about mid-August with the early varieties. Skill is needed to judge the correct time for pulling the cobs which falls within the "milk" stage of the grain. The grain must not be allowed to harden. On an average two or three cobs are produced by each plant although sometimes four are produced. They are either twisted off the plant or cut with a knife. The husks and "silks" are left on the cobs.

Marketing. The 12 lb. tomato box, lined with white paper which holds about 1 dozen good-sized cobs has been a successful package for sweet corn. The cobs are tender, require careful handling and must be marketed immediately after pulling. It is one of the crops suitable for handling by quick-freezing. It may be kept for 3 or 4 weeks at 32°F. Sweet Corn is also suitable for canning.

Seed Saving. While it has been amply proved that good seed of Sweet Corn can be secured in Britain from standard cultivated varieties, the production of hybrid seed is best in the hands of seed firms which have competent plant breeding staffs, and all facilities for harvesting and handling the crop. Seed, of course, is obtained merely by leaving the cobs to ripen on the plants until the latter dry off. They are then pulled and husked and given a further drying. When perfectly dry the grain is removed by hand or in a corn huller.

CHAPTER TWELVE

Early, Forced and Protected Crops

The production of early crops of vegetables and salads with the aid of glasshouses, frames, cloches and hand-lights has for many years been a special feature of the market gardening industry. It is noteworthy that the production of early produce for the English markets developed steadily in France and Holland and became a highly specialized business. The imposition of tariff duties on horticultural produce halted the steady growth of imports and awakened at home a general interest in the art of growing early crops. In consequence this section of the market growing industry has developed considerably during the last ten or fifteen years, and there is scope for even further development.

To-day the French frame and Dutch light are well in evidence in the market gardening districts, and their use has also spread to the large farms where farmer growers of vegetables have discovered that a unit of frames or Dutch lights is a useful addition to their business. The old French cloche (bell-glass) appears to have passed out of favour, but the Evesham hand light is still used and serves a very useful purpose. A new device known as the continuous, or running, cloche has, however, become popular, and has proved its value in commercial practice.

No attempt will be made in this chapter to give a fully detailed description of the methods employed for raising early crops with the aid of these structures and appliances, but sufficient will be said to enable the reader to grasp the fundamentals and appreciate the possibilities.

Soil Heating. Soil temperature is an important factor in

plant growth, and it is, therefore, not surprising that investigations of ways and means of artificially warming the soil, other than by means of hot-beds, have been pursued in recent years.

While subterranean pipes containing hot water have been used successfully for forced crops such as seakale, rhubarb and chicory, this system possesses practical difficulties when used for crops of normal growth. Commercial growers are now becoming interested in the latest development, that of electric soil heating, a practice that has now passed the experimental stage.

Soil heating is a valuable means of producing earlier crops both in the open and under glass or in frames, and is also useful for raising plants. Simplified systems are now available whereby the ordinary main electricity supply is used with the aid of specially-designed and inexpensive types of transformers and low-voltage soil-heating cables, the latter being of jointless coppered steel wire that resists corrosion and ensures long life The cables are laid without angles or sharp bends at 1 ft. to 1 ft. 6 in. below the surface of the soil and are energised at a low voltage. One firm manufacturing this equipment provide facilities for three different loadings, full (100 per cent), medium (50 per cent) and low (25 per cent). No thermostatic control is necessary with this electric soil-heating equipment, and the current may safely be left switched on at the desired loading.

Experiments of the British Electric Research Association have shown that 40 watt-hours of energy per sq. ft. per day (equal to 4 units per 100 sq. ft.) south of Lancashire and Yorkshire, and 45 watt-hours per sq. ft. per day (equal to 4·5 units per 100 sq. ft.) north of these counties, provide successful soil-heating conditions. Other experiments have shown that at least 6 units per 100 sq. ft. per day are necessary to give the most effective results, correlating to 12·5-15°F. rise in soil temperature according to local conditions. This is a matter for individual investigation, as such factors as local climate and type of soil are closely concerned.

The only point of difficulty concerned with soil heating, both by hot-water pipes and electricity, is the increased evaporation of soil moisture. The correct "field capacity percentage" for each type of soil must be maintained by watering, and as the use of cold water will lower the temperature of the soil the use of warmed water, at a temperature of 80-100°F. is prefer-

able if it is applied to the soil only. If sprayed on the plants the water's temperature should be not higher than 70°F.

Experiments have shown that soil heating by electricity results in forwarding crops, such as lettuce by from 2 to 3 weeks, apart from the fact that it enables two crops to be grown in the early season. Costs, based on industrial tariffs not exceeding 1d. per unit, have shown a good return on the capital and maintenance expenditure involved.

Glasshouses. Glasshouses, whether heated or unheated, are utilized for raising out-of-season and early crops of lettuce, radishes, carrots and turnips. Occasionally, crops of early potatoes and peas are grown under glass and have proved remunerative.

It is useless to try to grow the forcing or early types of lettuces in cold glasshouses. Such varieties as *May Queen* and *All-the-Year-Round* are the most suitable. A good plan is to sow the seed of these varieties outside in August, or in frames in seed of these varieties outside in August, or in frames in September, and plant the houses on October. If kept on the dry side the plants will winter successfully and usually turn in during March and early April when salads are scarce.

In heated glasshouses, on the other hand, specially suitable varieties such as *Golden Ball*, *Loos Tennis Ball*, *Blackpool*, *Gotte a forcer*, *Cheshunt 5B*, *Cheshunt Early Ball* and *Cheshunt Early Giant*, may be grown. The seed can be sown in heat fromOctober to January, the seedlings first pricked out in boxes, and when large enough put out in the houses. *Cheshunt Early Giant* is especially suitable for growing during the short days, and will form a heart under conditions that are less favourable to other types. The seed should be sown in October to give plants for planting out in November. A second planting may be made in January. Downy Mildew may be troublesome under glass, but the *Blackpool* variety resists one of the strains of this disease (there are at least two), *Loos Tennis Ball* and *Early French Frame* are also resistant.

Radishes of the short-topped, turnip-rooted varieties, such as *Early Forcing French Breakfast* and *Red Turnip Short Top Forcing*, may be sown during February and March in rows between the rows of lettuce, if the ground is unoccupied with other crops.

Turnips of the long or half-long frame types may also be sown in the same manner when the soil warms in the spring.

None of the above crops requires a forcing temperature; as a rule a temperature between 50° and 60° F. will bring the crops along at a steady pace. It should be noted that firm well-hearted lettuce cannot be grown in high temperatures under glass. Such conditions result in the production of large flabby lettuces that are difficult to sell.

Early crops of beans are grown under glass, but uniformly higher temperatures, from 65° to 70°F., are required for this crop to succeed well.

Early crops of vegetable marrows are often taken as catch crops in tomato houses, the white trailing variety usually being grown. The plants are generally trained up the purlin supports of the houses and interfere very little with the tomato crop.

Dutch Light Culture. This system of frame culture for the production of early vegetable and salad crops was not much seen or even heard of in England before the imposition of tariff duties on this class of produce in 1932. Interest has been aroused since that date, however, and much of the early produce received by the markets to-day is grown in this type of frame. Approximately 2,000 acres of land are said to have been covered with this type of frame in Holland, which gives some indication of the output capable of being attained by this class of production.

The Dutch light system is now well known in all its details, and can be recommended not only to those whose interest lies in the specialized business of producing early crops but to all growers of vegetables for market.

The Dutch light system in its simplest form consists of a wood or steel framework that may run to any convenient length, usually from 30 to 50 ft. This framework is arranged in series with alley-ways between and facing south preferably on a gentle slope. The frames are covered with "Dutch lights", each consisting of a light wooden frame approximately 60 in. long by 32 in. wide, with grooves into which a single sheet of glass is slipped (Fig. 41).

During the winter and early spring months these frames are used for the production of early vegetables and salads on the following lines. It should be borne in mind that the sowing and

planting of crops for Dutch light-culture depends on the district. In Devon and Cornwall, for example, it is possible to commence cropping from October onwards.

Lettuce seed of the *Early French Frame*, *Gotte a forcer*, *Northern Queen* or *May Queen* types is sown in the frames in October. For cold frames *May Queen* is most suitable. The plants so raised are set out in the frames, 24 plants beneath each light.

The plants grow steadily under the shelter of the lights, which are protected during severe weather by covering with reed mats, and usually turn in during the months of March an April.

Lettuces for cutting in February and early March cannot be obtained without heat derived either from hot-beds or from hot-water pipes or electric cables running through the soil beneath the plants. As a rule the cold frames will produce lettuce for cutting from late March onwards.

RADISHES are grown by broadcasting seed between the lettuces in the early months of the year. Good varieties of radish for the purpose are the *Forcing Scarlet* (turnip-rooted), *Forcing French Breakfast* (olive-shape) and *Woods Early Frame* (long shape).

CARROTS are grown by sowing seed between the lettuces during the month of February. The cylindrical *Early Nantes* type of carrot is preferred for frame culture; *Amsterdam Forcing* and *Ideal* being good varieties. The globe-shaped *Early Horn* type of carrot is also suitable; the variety known as *Early French Forcing Horn* is a useful variety of this type.

TURNIPS of the white, cylindrical type, e.g. *Long Milan*, may also be sown either between the lettuces or after they are cleared. The varieties known as *White Paris Market*, *Sutton's White Gem*, and *Early Long White Frame* are also suitable for early frame culture.

CAULIFLOWERS, plants of which are raised in cold frames and potted on, are put out in the frames towards the end of February. Varieties of the *Early London* type, such as *Pioneer*, *Feltham Forcing* and *Sutton's First Crop* are very suitable.

THE METHOD OF CULTURE. Briefly, the cultural methods employed with Dutch lights are as follows. The land is prepared in early autumn by giving it a thorough ploughing or hand

digging; it should be laid up as roughly as possible and ridg is to be preferred. It should not be allowed to get thorou cold, and if freezing conditions set in it is the best plan to c it with litter or other material. The land should be prep for the frames by laying down from 9 to 12 in. of fresh st manure, containing plenty of litter, to form a little bot warmth, which in turn is covered by about 6 in. of good s If possible, some form of humus such as well decayed, "hu fied", stable manure, old mushroom beds, or compost, sho be mixed with the soil. For the second and following years soil, with the addition of further humus, is used again. average districts, the beds may be made up ready for plant from December onwards, but as a rule January is early eno for unheated frames. Much depends on weather conditio for example, a set of unheated Dutch frames that were plan with lettuce on February 6, 1935, gave cuttings on March Carrots sown on February 6 were pulled for market on May Cauliflowers planted at the end of February were ready cutting from the end of May onwards.

After the principal crops are cleared from the fran towards the end of May, the lights should be stacked for saf unless they are to be utilised on other structures during t summer for tomato crops. The frames and lights may also used for growing cantaloup or Dutch types of melons, or bringing on early crops of vegetable marrows, two plants of t bush type of marrow being put out under each light.

Heated Frames. Very early produce cannot be grown witho a reliable form of heating. The French garden method placing the frames on hot beds composed of stable manure still used by some growers, while others have adopted one the systems of soil heating described above. When using h water two 1-in. pipes are tapped off a 4-in. main and burie about 12 in. below the surface. It is considered best to have a the pipes in the beds to be "flows" to ensure even heating This is easily arranged when installing the heating systen This is sufficient to furnish the amount of gentle heat require for each run of lights. It is clear that without this soil warmt lettuce cannot be obtained fit for cutting before the middle c March at least. With it a fortnight or three weeks are gaine Other crops are also relatively later when no heat is employe

With skilful management two crops of lettuces can be cut from heated frames while only one is obtainable from cold frames.

Another method of employing Dutch lights is being adopted with success. Instead of the single light frame described above, two lights are used in pairs to cover a bed 9 ft. wide (Fig. 32). The lights are supported in the centre by a wooden bar carried on short posts about 18 or 24 in. high, and thus, sloping down on either side, a structure resembling a miniature glasshouse is formed. Structures of this type are also used to raise early crops of hardier types of lettuce, such as *May Queen*. They are planted up in early March, the lights being kept on for a month or two until the plants are well established, after which they are moved to other frames to cover crops of early carrots, turnips, etc. Later still the lights are used to form the roof and sides of wooden or steel structures for growing summer crops of tomatoes, and remain there until required for lettuce etc., in the winter again.

From the above very brief summary of the Dutch light system it is clear that growers have at their disposal a very useful method of producing early crops of certain vegetables and salads. The noteworthy aspect of the system is the mobility of the Dutch light, which, on a well-organized establishment, need never be lying idle. When estimating production costs for early crops grown under this system it must be remembered that depreciation is an important item. Much of the material used, such as the wooden sides of the frame, will decay quickly, as it is not safe where plants are grown to use creosote or similar substances as a preservative. Although the lights will last in good condition for several years, especially if painted, or heated with a special type of preservative, the breakage of glass must be taken into account. Dutch lights should usually be depreciated at 20 per cent per annum to be on the safe side, which allows them a life of five years. With care, however, they will last for upwards of ten years.

French Frames. The small, almost square type of frame, having a light with three or four bars and glazed with small panes of glass, has been used in England for raising early crops for some 50 years or more. It was popularised during the so-called French-gardening boom during the first decade of this

century and has remained in use to some extent ever since. This type of frame is popular with growers who are able to secure large quantities of stable manure at reasonable rates to form the hot-beds on which the frames are sited. A range of French lights is shown in Fig. 34. This particular range is used for growing an early crop of lettuce, and after that tomato plants for an outdoor crop are raised in it.

The cropping system for the French frame usually follows that described for the Dutch lights. If used with well-made hot-beds, the produce can be secured during January and February from frames planted up in November and December, and other crops follow with relative earliness. From 4 to 5 dozen lettuces can be taken from a French frame as compared with 2 dozen from a Dutch light. Although mixed cropping is practised successfully it is probably a better plan to take single crops of lettuces, radishes, carrots and turnips in succession. Later in the season, as the hot-beds become "spent", crops of early beans are sown, or the frames are planted with vegetable marrows for early cutting, or with melons for the summer.

During the early part of the year the French frame requires adequate protection during spells of cold weather to conserve heat. Mats are used for covering the glass, and straw or long litter is packed around the sides of the frames. It is usually from this type of frame culture that the earliest crops are produced; it follows, therefore, that every care must be taken of the growing crops, and regular attention given to the details of routine cultivation if success is to be attained.

Frames heated by Electricity. The most recent investigation of this system of frame heating has shown that it is both practical and economic as a commercial proposition. If the frames are prepared in November and the heating wires inserted in the soil but not connected to the supply cable, the beds can be left exposed to the weather for a month. Early in January the lettuces are planted and carrot seed sown, and the heating systems are connected to the mains. The current is then switched on, and the lights are for the most part kept closed until the crop of lettuce is ready to cut. In this way both moisture and heat are conserved, and to assist in this the frames are covered on very cold nights with straw or bracken. The heating voltage is normally 24, the current being stepped down from the usual

mains supply of 200-250 by means of a simple transformer. The heating system is thus perfectly safe and no harm can come to anyone touching the live heating wires buried in the soil.

In the south of England the lettuce crop can be cut in from 8 to 10 weeks after planting, but in the north a little longer is required. In a recent price experimental cropping initiated by the technical staff of the Electrical Research Association the following interesting data were obtained with crops of lettuce :

Area sq. ft.	*Av. yield of lettuce*	*Cost of current per unit*	*Total cost of current*	*Overhead costs*		*Total cost*	*Net cost per lettuce*
				Heating equipment	*Supply wiring*		
		d.	*s.*	*s.*	*s.*	*s.*	*d.*
300	554	¾	73.5	8.0	2.5	84.0	1.82
750	1,385	½	135.0	8.0	2.5	145.0	1.26

It should be noted that much depends on low charges for heating current. Preferably it should not exceed 1d. per unit for this purpose.

The Evesham Hand-light. This hand-light (Fig. 40) was for many years a feature of the Evesham market gardening district. Its chief use is to provide protection for early outdoor crops, such as cauliflowers and vegetable marrows, but before the advent of the Dutch light and the continuous cloche, it was also used for growing early lettuce.

With the protection afforded by these hand-lights cauliflower plants can be put out early in April and afforded protection from late frosts. As a general rule three plants are put out in the form of a triangle under each hand-light. About mid-May the lights may be removed, and are usually then placed over vegetable marrow plants that have been raised under glass. Early crops of cauliflowers and marrows are grown on the same land by placing the rows of cauliflowers 4 to 5 ft. apart each way and covering them with hand-lights. Later the rows of bush marrow plants are planted out at similar distances between, and the hand-lights are moved over to cover them

until all risk of frost has gone. A field laid out in this manner is shown in Fig. 40.

Cloches. The old French type of "bell-glass" known as a *cloche* is no longer used to any great extent by market growers. Its place has been taken by the continuous cloche, a device composed of sheets of glass held in a strong wire framework.

CONTINUOUS CLOCHES. While it is not possible to give full details of modern cloche cultivation in this book (further details are available in another volume in this series*), it can be stated that the low-barn continuous cloche has been proved to be suitable for commercial holdings. (See Fig. 42 and 43).

The following crops can successfully be grown :—Carrots, Cauliflowers, Cucumbers, French beans, Lettuces, Peas, Radishes, Turnips, Tomatoes and Vegetable Marrows. Others, such as Sweet Corn, can be brought along, with the aid of the protection, several weeks earlier than normal.

The lay-out of the continuous cloche units requires that double the amount of land actually covered at any one time should be available, This allows for the cloches to be in use in strips or panels for the greater part of the year. The cloches are usually arranged in 4-panel units, each panel being 6 ft. wide, except that the first and every 4th panel is 8 ft. wide to provide a 2 ft. stacking space. It also ensures that the cloches have not to be moved any great distance, thus reducing risk of breakage; they are just moved from one panel to the next, i.e. in alternating panels. The low-barn type of cloche†, which covers a width of 23 in., are usually set out end-to-end in double rows with a space of 2 in. between the rows and a narrow space between double rows for a passage way. The ends of the cloche line are blocked with shaped boards to prevent a draught. The site should if possible be protected and slope slightly to the south to secure maximum warmth from the sun. Adequate provision should be made for supplying water to the growing crops. Irrigation systems are commonly used.

The cloche growing season begins in October when lettuce seed of frame types is sown, either under cloches or in a cold

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* Quarrell, C.P.: Intensive Salad Production.

† There are several types and sizes of cloche on the market. That most favoured for market work is the " barn " type with four panes of glass, about 23 in. wide and 16-18 in. in height.

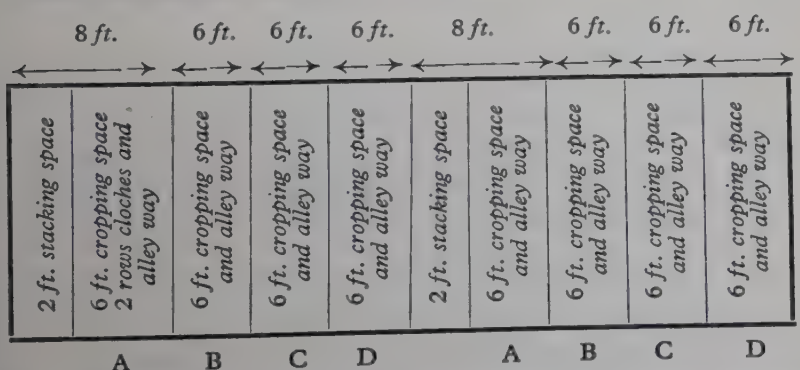
frame, to provide plants for putting out in the early part of the year. Planting is done as soon as the weather conditions are warm enough to secure steady unchecked growth (from January onwards according to the district) and the crop is usually ready for cutting during April and early May.

Carrot, radish and turnip seed (frame types) is sown from the the end of January to March according to district. Peas are sown in February and March and French beans in April and May according to district, the important point governing the sowing dates being that the seedlings once through the soil should never be checked. When these crops are nearing maturity the cloches are moved to cover French beans, tomatoes, marrows and cucumbers.

Tomatoes and cucumbers are very successful later crops for the cloches and the variety of tomato *Hundredfold*, because of its dwarf free-cropping habit, is an outstanding variety for cloche cultivation. A final lettuce crop may be taken by planting under cloches in August; this crop will mature in October.

Naturally many little problems arise in connection with this intensive and specialised type of production. Those concerned with the maintenance of soil fertility, watering and ventilation need exceptional care. The returns, however, are high, for this protectively-grown produce is of exceptional quality and commands high prices. Returns at the rate of £592 and £754 per acre were recorded in 1944 and 1945 respectively in a cloche cropping trial as far north as Edinburgh, laid down by the East of Scotland Agricultural College.

Diagram showing panel lay-out for continuous cloches



Note. The cropping of the panels is so arranged that cloches from A are available for B and those from D for C, and in reverse.

A Programme of Continuous Cloche Culture.

(1) *Crops for Autumn and Early Winter Maturity.* Lettuce—sown July/August for maturing from October to January. Varieties—*May Queen, Blackpool* (*French Frame*); *Spring Beauty, Improved Trocadero, Imperial, Winter Crop, Majestic.*

In suitable climates further successional sowings may be made at the end of September and early October. Both sowings to be thinned and covered with continuous cloches before weather becomes severe.

Endive—sown in late July or mid-August in open to be thinned and covered with cloches in late October. The variety *Batavian.* To secure blanching of the crop the cloche row can be covered with thick sacking or other suitable material.

Lisbon Onions—first sowing to be made in the open in late August with successional sowings. These can be cloched later in the season at onset of severe weather.

(2) *Crops for Spring Maturity in Open or for Re-planting.* Lettuce of the above varieties to be sown under cloches in mid-October and thinned or pricked out in January—two rows per cloche.

Cauliflower sown in late August or September in open to be pricked out under cloches to over-winter. Early the following year they are planted at their maturing distance and left under cloche until almost developed, or alternatively, they may be planted out from the nursery rows in their permanent positions in the open. Varieties—*All-the-Year-Round* (for first sowing and for raising when days lengthen at end of year), *Early London, Pioneer, Orion.*

Peas and Broad Beans sown in mid-November to be protected from weather and birds. The cloches are removed from the beans but with peas they can be either removed or left to mature the crop. Varieties—Broad Beans—*Seville Long Pod, Claudia Aquadulce.* Peas—*Little Marvel, The Lincoln, Foremost, Kelvedon Wonder, Meteor.*

Activities to commence as soon as the days begin to lengthen in January. Crops to mature under cloches—Lettuce of varieties *May Queen, Blackpool* (*French Frame*), *Cheshunt Early Ball,* etc., which have been over-wintered under cloches to be planted at maturing distance about mid-January, two rows per cloche.

Another method is to sow seed under cloches of winter varieties, such as *Imperial* and *Winter Crop* and thin out plants where they stand. Carrots or radishes to be sown broadcast as a partner crop from early February to the width of the cloche, or as rows on either side of the lettuce. Varieties—Carrots—*Amsterdam Forcing*, *Perfect Gem*, *Early Nantes*. Radish—*Short Top Scarlet Globe*, *Sparkler*, *Saxa*, *French Breakfast Forcing*.

Other crops to be sown and covered at this period include successions of dwarf peas, turnip-rooted beet, 3 rows per cloche, sown in February or March, of varieties, such as *Empire Globe*, *Egyptian Turnip Rooted*. Turnips broadcast of 3 rows per cloche sown from early February onwards. Varieties—*Ideal* or *White Gem* for warmer districts and *Early White Milan* or *Jersey Pearl* for others. Shallots to be planted to production of early "salad onions."

A portion of the cloches should be reserved for raising plants of cauliflowers as soon as the days lengthen; varieties—*Orion* or *Pioneer*. These plants are for successional outdoor planting.

Lettuce. Another batch of plants for successional planting outside to be raised in January under cloches. Good varieties for this purpose are the quick maturing *Gloria* and *May Queen*. Later still lettuce for summer crops may be sown varieties—*Feltham King* and *Market Favourite*.

Other sowings to be made for planting in the open later, include cabbage, varieties—*Primo*, *Velocity*, *Golden Acre*. Brussels sprouts—varieties—*Rous Lench*, *Cambridge No.* 5. Onions; varieties—*Rousham Park Hero*, *James's Keeping*, *Brown Spanish* for bulbing. Early leeks.

Later Work. Sowing of the following tender crops from early April to the end of May may be made according to district where they are to mature, the cloches being removed when all risk of damage by weather has passed.

Sweet corn—for light soils, *Adam's Early*, and for heavier soils, *John Innes Hybrids*, *Canada Gold*, *Golden Cross Bantam*, *Extra Early Bantam*, *Early Golden Market*.

Ridge cucumbers—*Wither's Ten-Weeks*, *Cheltenham Long Ridge*, *Bedford Prize Ridge*, *Stockwood Ridge*. (To gain time plants may be raised under glass from seed sown in March).

French Beans—*Black Wonder, Pershore Favourite, The Prince, Masterpiece, Lightning.*

Runner Beans—*Hollington Dwarf, Princeps, Streamline, Prizewinner.*

Tomatoes, to be raised for outside planting—*Hundredfold, Bide's Recruit, Devon Surprise.*

Crops to be raised under glass and planted and matured under cloches, could include Melons: *Dutch Net, Tiger.* Aubergines (Egg Plant). Tomatoes, for horizontal training: *Harbinger, Hundredfold, Stambovoi, Earliest of All, First in the Field.*

Forced Crops. Forced crops are vegetables produced out of their normal season by special methods, the term forcing normally implying the use of various types of structures together with artificial heat, the latter being usually derived from hot-water pipes. Only four important crops, viz., rhubarb, seakale Witloof chicory and mint, are generally forced for market, and it is noteworthy that all four crops have to be specially grown for forcing. A fifth crop, asparagus, is also forced, but to a much less extent than the others mentioned. Early crops of French beans grown under glass are not infrequently referred to as "forced beans", but the term is not strictly applicable. Forcing means the bringing into growth, by artificial means, of certain perennial or biennial plants out of their normal season of development when grown under ordinary outside conditions.

Rhubarb. Rhubarb forcing is a highly developed art, and it is not surprising that this business is largely in the hands of specialist growers, such as those located in the Leeds district of Yorkshire, a district famed for its forced rhubarb.

Varieties for Forcing. Forced rhubarb should possess both fine flavour and an attractive colour. The varieties grown should also possess good cropping capacity and while under cultivation preparatory to forcing be capable of quickly developing good, large roots with plenty of buds. The varieties commonly grown for forcing are *Linnaeus, Victoria, Prince Albert, Royal Albert* and *Timperley Early. The Sutton* is grown to a less extent. As regard Victoria it should be borne in mind

that there are several strains, with varying qualities both as to forcing and cropping. Daw's Champion is a rhubarb of very high quality when forced, but it does not possess the cropping capacity of Victoria. Royal Albert, on the other hand, is a robust grower in the field, and quickly develops roots of forcing size; it is useful for early forcing and is not the same as Prince Albert, a variety resembling Linnaeus.

Growing the Roots. Rhubarb for forcing must not be pulled while growing in the open, but all the plant's energy should be directed towards building up the crowns. On an average it takes three years' growth to develop the plants to forcing size, but under favourable conditions two years suffice for Royal Albert. The best crops of forced rhubarb are, however, obtained from three-year-old crowns.

Although many growers use the same land over again, a change is very beneficial. A rotation with crops such as potato and celery, which involve a good deal of working and aeration of the soil, is a good practice. In other words, after rhubarb plants of 2 or 3 years' growth are lifted for forcing the land should carry at least one, and preferably two, different crops before being planted again with rhubarb.

The land should be well prepared by giving it a deep ploughing and subsoiling and turning in a heavy dressing of well-rotted farmyard or stable manure. The grower should make sure that the manure is of good quality, and free from any plant refuse that might carry disease. Lime is also of value, and should be applied to rhubarb land from time to time, to reduce excessive acidity. Although rhubarb is one of the few crops that thrive quite well under acid soil conditions, lime is necessary to soil fertility.

Sets, obtained from healthy plants, are usually planted either 2 ft. 8 in. or 3 ft. apart each way (from 4,840 to 5,000 plants per acre). Each set should have one good bud and be planted so that the bud is just level with the surface of the soil. March is the best month for planting the crop.

The rhubarb forcer must plan his cropping in such a way that year after year there is a succession of crowns fit for lifting. This means that some amount of fresh planting must be done every year without fail. Roughly speaking, an area of one acre of forcing sheds requires about 40 acres of land con-

stantly under the crop to keep it supplied regularly with roots suitable for forcing. This estimate is based on the fact that the roots from 12 acres of land can be forced every year in an acre of forcing-sheds. The additional 4 acres are required for propagation stock. When planning, an allowance must also be made for land to be rested from the crop. This means that 1 acre of forcing sheds require at least 50 acres of land in cultivation.

Fertilizer. Developing rhubarb roots are much benefited by a regular application of a complete fertilizer. Each year after planting, the land should receive from 600-1,000 lb. per acre of a fertilizer mixture possessing an analysis of approximately 5-10-5 or 4-8-4. This mixture should be sown down the rows in early spring, and be hoed or cultivated in on the first fine day.

Cultivation. The growing plants should be kept free from weeds as much as possible. During the first year's growth, frequent hoeings may be necessary, but during the second and third years' growth the plants themselves assist in smothering weed growth.

Forcing the Crop. Rhubarb forcing sheds are usually low span-roofed structures of wood, from 25 to 30 ft. wide, heated with hot-water pipes. Provision is made for ventilation, but no outside light is admitted, if required for working it is usually obtained from electric lamps.

The roots for forcing are lifted in the autumn, commencing with the early varieties. The correct time to lift rhubarb depends on the state of maturation, and this in turn is influenced by weather and soil conditions. If lifted too early the roots are almost useless for forcing; in fact it takes considerable experience and judgment to gauge the correct time. The roots are lifted with either a spade or a specially-adapted plough, but care should be taken to prevent undue damage to the fang roots.

The lifted roots are packed closely together on the earth floor of the forcing sheds, and covered with a light layer of soil or well-rotted manure. The first pullings may then be obtained in from 3 to 4 weeks. It is a good plan not to force the roots "to death", so that, when taken out, if not too impoverished, they can be re-planted in the field, and be re-

conditioned—a process that takes two or three years and cannot be repeated more than once or twice with the same batch. Many growers, however, force the roots to death and then scrap them, while others cut up the roots after forcing to make planting sets; such sets, it should be said, are not so strong as those taken from healthy, unforced stock.

PULLING AND MARKETING. Each stick of forced rhubarb should be carefully pulled away from the crown without damaging the growing bud. The use of the fore-finger, which is pushed down the base of the stick into the sheath, is helpful. As gathered, the sticks are laid in long clean boxes, and taken to the packing shed.

Formerly, forced rhubarb was made into small lots weighing from 6-8 oz. (1 to 3 sticks, according to size); bundles were tied top and bottom with soft "fillis", or rubber bands are slipped over them. Forced rhubarb must be handled with care, as the delicate skin is easily bruised. It is now marketed loose.

The non-returnable wooden crate, with dimensions of 28 in. by 11¾ in. by 7⅛ in., holding about 6 dozen bunches, is a good standard package for forced rhubarb, while wicker flats and hampers and returnable wooden boxes are also used.

Seakale. Seakale has long been a crop of some importance to market growers, there being a certain regular demand every season for this high-class vegetable, especially when it is forced. Seakale is a hardy perennial plant, and it is the tender young blanched shoots and leaf stalks that are eaten.

PROPAGATION. Seakale is propagated by means of "thongs", the term applied to pieces of the large fang roots, removed from the plants after they are lifted each season for forcing. The end of each piece of root that was near3st the main root will, in due course, form buds and give rise to another plant. The thongs are prepared for planting by giving a square cut at the growth end, and a sloping cut at the rooting end, and each thong should be from 4-6 in. long. After preparation, they are laid in sand until planting time in the spring.

SOIL AND MANURING. Seakale thrives best in deep, sandy loams that contain lime, and the situation should be open and

fully exposed to sun. Roots for forcing should be grown on deeply-worked and well-manured land. Farmyard manure suits the crop very well, and up to 20 tons per acre should be applied before ploughing. Just before planting the thongs, from 4 to 5 cwt. per acre of superphosphate (18 per cent) should be broadcast and well worked in. Many growers of seakale hold the view that common salt is a beneficial fertilizer for growing seakale, while nitrate of soda is known to be a good top-dressing. From 1 to 2 cwt. per acre of either substance should be sown down the rows after the plants are commencing to grow away in May or June.

PLANTING. The thongs are usually planted during the month of March. The rows should be 2 ft. apart, and it is a good plan to allow 3 ft. after every fifth or sixth row, to facilitate cleaning, lifting, etc. The thongs may be planted by hand with a dibber, or laid upright in trenches struck out with a specially-adapted plough in such a way that the crowns are covered by about 1 in. of soil.

CULTIVATION. The growing plants should be kept free from weeds, and the surface soil should be frequently moved. The object is to develop as rapidly as possible, a strong plant suitable for forcing, two years being generally needed. An essential operation is the pruning away of all surplus shoots from each plant in the first season of growth. Each planted thong may throw up several shoots, but only one, the strongest, should be left to form the new crown. Flower stems, if they appear, should be cut off.

Some protection from frost may be required if the plants are left in the land through the winter; several inches of long litter or leaves usually provide sufficient protection.

FORCING. Seakale roots for forcing are usually taken up in October or November. They are trimmed, cleaned and stored until required.

Seakale is usually forced in specially laid out covered forcing pits, heated with hot-water pipes run off a special boiler installed for the purpose, or electric heating may be employed. Forcing should not be hastened as high temperatures tend to produce spindly, unattractive heads. The hot-water pipes run through

the soil of the bed, in which the roots are plunged, at a depth of about 18 in. and spaced 4 or 5 ft. apart; if closer, the soil tends to dry out excessively.

Well designed seakale forcing pits enable the crop to be forced quickly, with resultant produce that is firm, clean and attractive.

CUTTING AND MARKETING. Forced seakale should not be less than 6 in. in length when cut. It is usually cut with about 1 in. of the crown attached, and it should be handled carefully to avoid breaking and bruising the tender growth.

Wooden boxes measuring 16 in. × 10 in. × 3½ in., lined with blue paper and holding 6 lb. of produce, are suitable standard market packages. Seakale is also packed in chip baskets, or similar packages, holding 4 lb. The wooden tomato box, holding about 8 lb., also makes quite a good package for forced seakale.

Witloof Chicory. This vegetable used to be imported in large quantities from the Continent every season. Its popularity seems to be increasing steadily. Although grown in England to some extent, its cultivation could be extended. Witloof chicory must not be confused with the chicory grown for roasting and blending with coffee, or the salad chicory of the French. Although of the same species of plant (*Cichorium intybus*), the varieties grown for the respective purposes are quite different. Well-grown Witloof chicory provides a useful crop for marketing in the winter and early spring months.

The crop is treated as a biennial, that is, the roots are grown from seed in one year, and are forced during the early months of the succeeding year. After forcing, the roots are discarded, (they are useful for feeding stock), and a fresh crop must be raised for forcing in the following season.

Varieties. The *Witloof*, *Brussels* or *Large-rooted Brussels* is the variety grown for forcing. This variety is not the same as the salad chicory, much grown in Paris and known as *Barbe de capucin* (see salad crops), and care should be exercised to ensure obtaining not only the correct kind of seed but also a good strain.

SOIL. Witloof chicory should be grown on deep, sandy loams,

partly because it is easier to lift the roots without unduly damaging them on such types of soil. While the land should be in good condition and be deeply worked, manure is not strictly necessary. Before the seed is sown, the land should receive an application of a complete fertilizer of 1-2-2 ratio. As a general recommendation, 500 lb. per acre of a mixed fertilizer possessing 4-8-8 analysis should suffice to raise a good crop of chicory roots on land in a fair condition of fertility.

Sowing the Seed. The seed of this crop should be sown rather late, May and early June usually being sufficiently early. If sown earlier, the roots are inclined to become too large, and a proportion may bolt to seed during August. Bolted plants are useless for forcing.

The seed should be sown in rows from 12-15 in. apart, this taking about 2½ to 3 lb. of seed per acre. A good tilth is a considerable advantage when sowing chicory seed.

After-Cultivation. When the seedlings are through the soil they should be thinned as soon as possible, so that the plants stand from 4-6 in. apart. The land should be repeatedly hoed until the plants meet in the rows.

Forcing the Crop. The roots of Witloof chicory should be lifted in October and November, dried, and stored in such a manner that severe frost, to which they are sensitive, will not affect them. Although the roots may be ploughed out, lifting by hand, using forks, is the best method. The foliage should not be removed—if it is, the new growth, which is to be the "chicon" is encouraged before it is required. After drying the roots may be laid in shallow trenches and covered with straw, or may be stored in barns.

The crop may be forced, after the manner of seakale, in low, roofed-over forcing pits heated by hot-water pipes or electric cables, which run through the soil of beds in which the roots are plunged. While being the quickest, it is also the most expensive way.

Cheaper, but slower, methods are available by using glass-houses, sheds and barns, or by forming "natural" forcing pits about 7 ft. wide and 18 in. deep out-of-doors. Whichever method is practised the old tops are cut off about 1½ in. above the crown, the tips of the roots are removed to shorten them,

and the roots are packed in closely together and covered completely with about 9 in. of dry, sandy soil, which should contain no decomposing manure, but be fairly compact.

When forcing beds are made out of doors, the growth of the chicons may be accelerated by covering the beds with a thickness of about 18 in. of long stable manure, the heat from which will warm the soil. Heat is also sometimes derived from hot-water pipes. It is possible to conserve this heat and also protect the beds from excessive rain, by covering the beds with thatched hurdles, sheets of corrugated iron, Dutch lights, etc.

The best quality chicons are grown at a temperature of 55° to 65° F. At the latter temperature, the forcing usually takes from 3 to 4 weeks, which means that several batches of roots may be forced in succession during the same season, starting with the month of December.

Cutting the Crop. Forced Witloof chicory is cut just when the tips of the chicons peep through the top covering soil; in the case of outdoor beds before they come in contact with the covering of manure. The roots are pulled out of the bed, and each chicon is broken off with a sharp twist. In the packing shed the chicons are carefully trimmed to remove discoloured leaves, but washing is detrimental. Two grades are usually made—the first consisting of clean, firm chicons about 6 or 8 in. long, and the second the looser and longer chicons.

The best packages for marketing Witloof chicory are the 12 lb. tomato box and the 14 lb. plum box. Both can be made to hold 12 lb. of chicons, and should be lined with blue or white paper before packing. A sheet of grease-proof paper should be inserted between each layer or so of chicons, which are packed loose, with their bases towards the outside of the box.

Mint. There is a good demand for forced mint in the early months of the year, quite a large acreage being grown especially for forcing, notably in the Willingham district of Cambridgeshire and in the Worthing district of Sussex.

Soil for the Crop. Mint succeeds best on cool, moist, but well-drained loams. Crops grown for forcing should be specially grown and be left to develop large, strong rhizomes for lifting. As a rule the crop is taken up and forced after a single season's growth, but occasionally it is left down for two years.

LAND PREPARATION. Experienced mint forcers hold the view that the best forcing material is grown on land that was well manured for a previous crop. If manure is applied for the crop it is said to encourage the production of rhizomes with long internodes, so that fewer shoots are produced in the forcing house. On poorer soils, however, manure may be used with good results. The best manurial treatment is the use of a complete fertilizer mixture of the 1-2-1 ratio. The land should be deeply worked and be brought into a very tilthy condition for planting. A week before planting, from 500 to 800 lb. per acre of complete fertilizer having approximately a 4-8-4 or 4-8-6 analysis should be well worked into the soil.

PLANTING. Mint is propagated by "suckers" which are plants possessing a little root system, drawn from a specially reserved nursery bed. The plants are set out in rows about 9 in. apart, with 15 in. between the rows. Alley-ways of 2 ft. width should be left every sixth or eighth row of plants to facilitate cleaning. The free use of the hoe will not be possible during the later stages of growth, as the stolons would be cut and damaged; hand-weeding must therefore be done.

CULTIVATION. Careful cultivation should be given, to avoid damaging the creeping stolons. When the plants are established, a top dressing of a nitrogenous fertilizer, such as nitro-chalk or nitrate of lime, at the rate of from 100 to 150 lb. per acre will greatly benefit the growing crop.

FORCING THE CROP. Mint is usually forced in heated glass-houses of the type used for tomato growing. The whole root-system, including the rhizomes, is lifted from the open land in November and December. This material is then laid out thinly, but evenly, on the well-prepared borders of the houses and covered with abour 1½ or 2 in. of fine sifted soil. No manure is necessary for forcing the crop, but a dressing of soot imparts a good colour to the mint. Water must be given freely as required, and a house temperature of about 65° F. should be maintained. Growth is usually completed in a period ranging from 4 to 6 weeks after forcing commences. Forced mint may be obtained from Christmas onwards, but the bulk of the crop is usually grown for marketing in March and April when the demand is keenest.

A watch should be maintained for the appearance of aphides and of mint rust, as both are capable of spoiling the crop.

MARKETING. The growing shoots of the mint are pulled, not cut, and tied in bunches the size of which varies according to season. The best length of shoot is about 9 in. The bunches should be allowed to stand upright in water for a few hours before dispatch to market.

Forced mint should be packed in wooden boxes or lettuce crates lined with grease-proof paper. A market unit usually consists of from 2 dozen to 4 dozen bunches, but occasionally 6 dozen bunches are put up in one package. The grower should ascertain the requirements of the various markets he intends to serve.

Forced Beans. Although, as explained at the outset of this chapter, the term *forced* is not strictly applicable to the culture of early beans under glass, the market definition of this produce is usually 'forced French beans'. The subject is therefore dealt with here.

This crop can be very useful, especially in seasons when the outdoor crops are late through adverse weather conditions. In ordinary times home-grown beans first arrive on the market during January, coming mostly from the Channel Islands, and continue in supply until April and May. The bulk of the English house-grown crops are usually marketed in March and April.

The beans are generally grown in large 16-in. pots, or in the open borders. Pot culture is a useful method as the beans can be grown as a catch crop with cucumbers. The crop requires a high temperature, from 66° to 70° F., together with a high degree of humidity.

Varieties. The green-podded varieties *Black Prince*, *Earliest of All*, *Masterpiece*, *Ne Plus Ultra*, *Fifty Days*, *Satisfaction*, *Superlative*, *The Wonder*, *Canadian Wonder*, *Lightning*, are all suitable. *Ne Plus Ultra* is one of the most popular market varieties.

The climbing form known as *Climbing Canadian Wonder* and *Tender and True* (Sutton), are also suitable for glasshouse culture, but they require more room.

SOIL. The soil is an important point in glasshouse culture.

For pot culture, only fresh fibrous loam of a light texture, mixed with decayed stable manure (such as exhausted mushroom beds) and a little steamed bone flour or superphosphate (one quart to a barrowful), should be used.

Raising the Plants. Although the seed may be sown direct in the 16-in. pots, 5 or 6 beans to a pot, it is a good plan to raise the plants in small, 60 size, pots and transfer them to the large pots later. For bed cultivation the plants may be raised and transplanted in the same manner, or the seed may be sown in the border.

Marketing. Glasshouse-grown beans require careful handling. Only straight, well-grown, tender beans of a good colour should be marketed. No seedy beans should be included, as only a few may easily reduce the value of the whole consignment. They should be laid out straight and in regular layers in the market packages, which are usually chip baskets, containing 4 or 6 lb. of beans, or cross-handle wicker baskets containing 12 lb. of beans. The packages should be lined with blue tissue paper and each should be carefully fastened down, This is a vegetable crop that commonly makes high prices if the produce is of high quality, and it pays to take extra care in marketing.

Forced Vegetable Marrows. Crops of early vegetable marrows are grown in heated cucumber and tomato houses, usually in association with those crops, the marrow plants being allowed to run up the purlins and other supports. Each plant should be provided with about a bushel of fresh turfy loam mixed with well-rotted manure to give it a start. The top-dressing of fertilizer given to the tomatoes or cucumbers usually keeps the plants in a productive condition subsequently. The plants are not much in the way, and early fruits usually make high prices if packed carefully in chip baskets, cross-handles or in cucumber boxes lined with wood wool and blue tissue paper.

To obtain a good set of fruits it is a good plan to pollinate the female flowers early in the morning when, as a rule, both male and female flowers are open. Marrows do not set too freely under artificial conditions and, unlike cucumbers, are not parthenocarpic and will not form seedless fruits in the absence of fertilization.

CHAPTER THIRTEEN

Culinary Herbs, etc.

A fairly large acreage of land is devoted to the commercial production of kitchen herbs which are in demand for such purposes as sauces, flavouring, garnishing and the like. Only five of these crops, however, can claim to possess any substantial value in the field of commercial horticulture. These are parsley, mint, sage, horse radish and thyme. Parsley and mint are both grown fairly extensively, the former being a noticeable feature of the Bedfordshire market gardening industry, and the latter a crop of some importance in Cambridgeshire and the Home Counties. Sage is a crop of some importance in Worcestershire and Surrey, and horse radish has long been grown in the Middlesex market gardens, although much of the last named commodity is imported from the Continent.

Parsley. Parsley, being in constant demand for various purposes, has been known to realise high prices when supplies run short. A considerable quantity is grown in Bedfordshire, where it over-winters well on the warm light loams of the Biggleswade district. It has been a custom in that county to grow parsley in company with spring-sown onions and early carrots, so that when these crops are cleared the parsley is left as a second crop on the land. This practice has little to commend it as onions, especially, need the land to themselves.

VARIETIES. Although three types of parsley are known, only varieties of the curled type are widely grown by market growers. A good variety of this type should be long stemmed, closely curled, of a dark emerald green colour, and able to stand the winter without discolouring. Most seedsmen offer food varieties of parsley suitable for market growing.

Soil. A well-drained sandy loam in a good condition of fertility is the best for parsley. Cold clays and chalky loams are not so suitable as the crop must over-winter on the land.

Preparation of the Soil. A thorough preparation of the soil is very essential, for the seed should be sown on a fine tilth only. The thorough preparation usually given land for onions suits parsley very well, which is probably one of the reasons the crop is often sown with onions in Bedfordshire. Another reason for sowing the crop with onions, etc., is because the seed is of slow germination, taking several weeks to come up, and the onions or carrots coming up first enable the rows to be discerned for land cleaning purposes. The onions also afford some protection to the young, tender parsley plants in their early stage of growth. It is also claimed, but not proved, that the presence of parsley in the onion crop wards off attacks of the Onion Fly.

Manurial Treatment. If grown with onions, the manurial treatment accorded that crop is available for the parsley. If grown alone it is best to select land in good condition from the manuring of a previous crop. A nitrogenous fertilizer may be applied as a stimulant after the plants are well-established, and take the form of 120 lb. per acre of nitro-chalk, nitrate of soda or sulphate of ammonia sown down the rows and hoed in. It is, however, easy to spoil both the flavour and over-wintering qualities of the crop by using too much nitrogen.

Sowing the Seed. March and April are the best months for sowing the seed. If grown alone, parsley should be drilled thinly in rows 12 or 15 in. apart. The seeding should be at the rate of from 5-6 lb. per acre, and mixing the seed with dry sifted wood ashes will enable it to pass freely through the drill. A little radish seed may be sown with the parsley to enable the rows to be discerned for cleaning purposes before the plants are up. If sown with onions, the seed may be mixed with the onion seed, but some growers prefer to drill the seed on top of the onions as it should be less deeply covered than the onions, ½ in. being sufficient.

After-Cultivation. The parsley plants should ultimately stand 9-12 in. apart, and to secure this the seedlings should be thinned twice, first to 4 or 6 in. and later to the final distance.

MARKETING. Parsley is usually in demand from the early autumn onwards throughout the winter and the early spring months until the plants run to seed. The largest leaves are usually picked as they develop and tied in bunches in the field. The size of the bunches varies, but the London markets are accustomed to large bunches weighing from 2 to 2½ lb. The Bedfordshire growers usually dispatch units of 60 lb. of bunched parsley packed in mats or in large cabbage crates or bags. If scarce, the parsley is sent away loose in lettuce crates, so that retailers may make up their own bunches. The two-bushel returnable wooden box is also used for the parsley trade.

SEED SAVING. Parsley is a biennial plant producing seed the second year of its growth. Seed can be saved in the manner described for celery.

Mint. Fresh mint, grown in the open, is in fair demand from April to the end of September, but viewed as a commercial crop is probably not so remunerative to growers as forced mint, the production of which has been described. Those who grow forced mint usually market out-door crops as well, and so maintain the continuity of supply that is an important point with these kitchen herb crops. Market salesmen are accustomed to receiving supplies from certain growers, and are thus able to order fresh supplies quickly by telephone should there be a temporary shortage. In fact, as all the crops dealt with in this chapter exist on a basis of a fine adjustment between supply and demand, over-production may easily disturb the economic value of the crop. Crops of this kind should not be grown extensively unless there is a market in view.

SOIL. Mint thrives best on moist, loamy, free-working soils that are not apt to run together or cake. In preparing land for mint great care should be taken to clean it thoroughly as perennial weeds, such as thistles and couch grass, will quickly ruin the crop. A moderate application of farmyard manure should be ploughed in, and the land sub-soiled if required. The cleaner the land to commence with, the longer the crop can remain on the same piece of land.

VARIETIES. Several species of mint are grown in gardens, but for market *Mentha viridis* (*M. spicata*) and *Mentha villoso-nervata* are the two most commonly grown. The former has

become known as the Cambridgeshire type (it is also much grown in Cheshire and Lancashire), and the latter as the Middlesex type, in which county it is almost exclusively grown. Both varieties make rapid growth and force well under glass. Peppermint (*Mentha piperita*) is another species of mint grown for its essential oil, which is obtained by a distillation process. It is too strong for culinary purposes.

Preparation of Soil. For out-door crops of mint it is advisable to put up the land in "stretches" at the final ploughing. This effects good drainage, and the alley-ways between the "stretches" are useful as foot-ways for cleaning purposes.

Propagation. Mint is chiefly propagated by suckers (young plants drawn from established beds in April), which are set out with dibbers in rows 12 in. apart with a space of 10 or 12 in. between each plant. The underground rhizomes, termed "runners", are also occasionally used for planting fresh land.

After-Cultivation. It is very important that the mint beds should be kept clean, at first by hoeing between the rows, and later by hand weeding. With care in cleaning, the crop can remain on the same land for 3 years. Top-dressings of sulphate of ammonia or nitrate of soda, at rate of 1-2 cwt. per acre, are applied in the spring and early summer to stimulate growth.

Marketing. Mint is usually cut and tied in bunches of various sizes. London markets require large bunches (24 to a bushel box), while the northern markets prefer rather smaller bunches of about 8 or 10 shoots. The bunches should be stood in water for a few hours before dispatch. Wooden boxes and wicker hampers are the best market packages. Several cuttings are taken from the beds during the season.

Sage. Sage is in demand in most markets, while packers of mixed herbs also require supplies for drying.

Varieties. There are several types, but the one usually cultivated for market is the Green Sage, of which there are two varieties, viz., the *Narrow-leaved* and the *Broad-leaved*. The former, which develops greyish-green, downy leaves, used to be the most popular market sage. The latter, which develops broader, and less downy, leaves of a darker green colour, has sold well in most markets in recent times.

Soil. Sage thrives best in a warm, dry climate, and on light soils of a calcareous character; hence it is often grown on land that is not so suitable for the successful production of other vegetable crops. The crops will also do well, and yield even better crops, on stronger soils, such as those found in the Evesham district where sage is grown fairly extensively.

Preparation of Soil. As the sage plant is a small shrub that will remain as a permanent and productive crop on the same piece of land for several years, growers when preparing fresh land for the crop, should give deep cultivation, and plough in a fair application of farmyard manure.

Propagation. Although many propagate sage by pulling old plants to pieces and planting up the fragments, each with a piece of root attached, the soundest plan is to root selected cuttings in sandy soil in a cold frame. The cuttings should be pulled off with a ''heel'' and if inserted in May or June, should be rooted and ready for planting out in September. Cuttings may also be taken in September in the ordinary manner, and these will root readily during the autumn if treated with one of the growth hormones before planting in frames. Plants from these cuttings are planted out the following spring. The rows should be from 2-3 ft. apart, and the plants 18 in. apart in the rows.

After-Cultivation. Good sage cannot be grown unless the land is maintained free from weeds and frequently cultivated. Every spring a light application of a fertilizer, providing nitrogen and potash, should be applied between the rows and be hoed in. A satisfactory treatment is 150 lb. of sulphate of ammonia and 100 lb. of muriate of potash per acre, and will be just sufficient to stimulate growth and impart a good appearance to the leaves and shoots by gathering time. The plants should be prevented from seeding by cutting off the flower shoots as they form.

Marketing. The leafy shoots of the sage are usually pulled off the plants and bunched, but in some districts the whole plant is cut and the land cleared in one season. As a rule, however, sage is grown for an established and regular trade the particular requirements of which are well known to the

grower. When consigned to market sage usually consists c bunches containing about 12 shoots, but larger bunches ar made for the Londone trade. For drying and packing purpos the sage is usually sent away unbunched, but it must reach th packers in a fresh condition. Packers usually make their ow arrangements for collecting supplies.

Sage is dispatched in wooden or wicker packages of variou sizes : about 15 dozen bunches are packed in the Evesham po hampers.

Horse-Radish. The roots of this plant (*Cochlearia armoracia L.*) when well grown are in demand for sauce making both or the market and with firms of sauce makers. The straight, thick roots required by the markets are obtainable, however, only by special methods of cultivation. Poor quality roots are not required. The method usually practised is to grow the plants in well-prepared beds having a deeply-worked and well-manured soil.

PROPAGATION. Horse-radish is propagated, after the manner of seakale, by means of pieces of young root removed from matured plants at lifting time. These pieces of root, called "thongs", about 6 in. or 8 in. long, are laid in beds of sandy soil until March, by which time they have usually sprouted and are ready for planting. The best roots for planting are about the thickness of a pencil. The sprouted thongs are planted in large holes made with a dibber, or are laid upright in trenches taken out about 1 foot deep. The thongs should be set about 9-12 in. apart in the rows, which should be about 2 ft. apart.

MARKETING. The roots of horse-radish should usually be ready for lifting in November or December, after a season's good growth, and certainly after two seasons' growth. Only good, straight, thick roots are required for market. These should be freed from soil by washing, if necessary, and tied in bundles of three and twelve, such bundles are tied into another bundle. Good well-grown horse-radish is always saleable, but inferior produce is not required.

Thyme Thyme is marketed as a green herb, and is also saleable for drying as a constituent of the dried mixed herbs put up in packets.

Two varieties of what is known as garden thyme (*Thymus vulgaris*) are grown for market. These, the *Broad-leaved* and *Narrow-leaved*, are alike in all respects except the leaf character.

Like sage, thyme thrives well in a warm, well-drained, sandy or calcareous soil. It is not happy on cold, wet soils. As the land for the crop should be fairly fertile, a moderate application of manure should be given when making new plantings.

PROPAGATION. Thyme is propagated by pulling to pieces the old plants and planting each fragment possessing a little root. The rows should be spaced at least 2 ft. apart and the portions planted 18 in. apart in the rows. Good plants may also be grown from cuttings taken with a "heel" and rooted in frames. Seed, although occasionally sown, is apt to produce a variable stock.

CULTIVATION. If kept clean and manured, the crop will last for several years on the same land. A nitrogenous fertilizer, such as nitrate of soda or sulphate of ammonia, applied at the rate of 150 lb. per acre in the spring, acts as a useful stimulant and promotes the growth of fresh shoots.

MARKETING. Like sage, the leafy shoots of thyme are pulled off in late summer and bunched—12 shoots to a bunch. Wooden boxes and wicker baskets are used as market packages.

Contracts for supplies are usually made with the herb drying firms.

Caraway. CULTIVATION OF CARAWAY AS A SEED CROP. We have had little experience of this crop in recent years, It used to be grown in Essex and Kent and other seed growing districts where the climate of the late summer can be depended upon for the work of harvesting the crop. The root is edible but is seldom used. The leaves and shoots are occasionally eaten.

Caraway is a biennial plant, and must, therefore, be sown on the land where the crop is to stand until it matures during July or August of the following year. The crop prefers a light, warm loam on which a good surface tilth can be obtained for the seed-bed.

The seed should be drilled in rows of 10 in. apart, May being

a good month for sowing, though June sowings are normally quite successful. The plants are singled to about 8 in. apart when 2 in. or so high.

If the land is in good shape, dung need not be applied, but the application of a complete fertilizer of the carrot or sugar-beet type is advisable. This should be cultivated into the seed-bed a week or so before sowing. Lime is essential: the crop does not thrive on acid soils.

The growing crop should be kept well cultivated as a surface tilth seems to suit it.

When the seed is ripe the crop is cut, dried and stacked, being treated as a normal seed crop.

CHAPTER FOURTEEN

Pests and Diseases of Vegetable Crops, Insecticides and Fungicides

Nearly all vegetable crops are attacked by animal and insect pests and diseases of a fungal or bacterial origin. Sometimes certain of these pests and diseases have a wholly destructive effect on the crop, while at other times the effect is only partially destructive, or the damage may be comparatively slight. Whatever the effect produced, the commercial grower of vegetables should at all times be prepared to adopt combative measures in order either to alleviate or eliminate the trouble. Practical growers cannot be expected to acquire the knowledge of plant pathologists or economic entomologists, and in all instances where serious damage is being inflicted on crops by pests or diseases they are advised to call in the horticultural advisory officer appointed for their county, whose services are free. This officer may in turn call in the Advisory Entomologist or Mycologist for his province. These officers are trained specialists who are competent to deal with problems associated with the pests or diseases of plants, although, it must be admitted, not all pests or diseases can be dealt with by the application of straight-forward simple remedies, such as spraying or dusting with insecticides on fungicides, or poisoning with specially prepared baits. Some of the troubles, such as those concerned with plant eelworms, are of a complex character and admit of no easy control measures.

In addition to the destruction caused by parasitic organisms of a fungal or bacterial character, and the predatory attacks of insect and animal pests, including birds, a new group of disease conditions associated with what are termed plant

viruses has been discovered and studied in recent years. They are transmitted from plant to plant mostly by insects, chiefly aphides. The virus diseases are, in fact, developing into the most serious problem concerned with the preservation of a healthy condition in plants of economic importance. They are the more serious because the affected plants cannot be treated with remedies—in other words, stocks infected must be discarded entirely.

Amongst vegetable crops virus diseases are found notably in potatoes and shallots, both of which are propagated vegetatively, a practice that tends to spread the trouble. There is no "cure" for these maladies, the only remedy is to discard infected material in favour of healthy stocks. Virus diseases occur also in the lettuce, bean, pea, beet, turnip, swede, cucumber, marrow, watercress, tomato and cabbage crops.

Lastly, a further group of impaired health conditions has been identified in recent years as being due either to deficiencies of the major elements—calcium, phosphate, potash, etc.—or deficiencies of minor elements, e.g. magnesium and boron deficiencies found in the Brassica crops. These conditions call for treatment by applying the deficient substance—often in quite small quantities. In such cases the provincial soil chemist may be consulted.

No attempt is made in this chapter to give a full list of the pests and diseases of vegetable crops. Some of the more important pests and diseases that may be encountered in the ordinary course of crop production are mentioned in the notes under each crop. Over 30 years' contact with the vegetable growing industry has led the author to believe that good methods of cultivation and manuring, the use of good, healthy stocks of seeds, a proper system of rotation and hygienic methods all make for healthy crops that resist disease and stand up against attacks by insects and animals.

Diseases Caused by Fungi, Bacteria, etc.

ASPARAGUS: Rust, due to *Puccinia Asparagi*, causes damage of a spasmodic nature. Violet Root Rot caused by *Helicobasidium purpureum* attacks the underground portion of the plants and is fairly prevalent in the older established beds.

ARTICHOKES. Plants are often attacked and killed by Sclerotinia disease in the south and tubers in storage may be attacked. *S. Sclerotiorum* is usually said to be the fungus concerned, but *S. minor* has also been found associated with the disease.

BRASSICA CROPS. All members of the cabbage family are attacked by Club-Root, a condition caused by the slime fungus organism *Plasmodiophora Brassicae*, particularly in soils deficient in lime. Ring Spot caused by *Mycosphaerella brassicicola* occurs chiefly in cabbage, brussels sprouts and broccoli in varying intensity from season to season, mostly in the south-west and in Wales. Downy Mildew (*Peronospora parasitica*), causes a fair amount of damage in some seasons, particularly to plants under glass or in frames in the seedling stage. Grey Mould (*Botrytis cinerea*), often sets up rotting and decay in the hearts of cabbage in the south during damp winters. Other diseases that cause serious damage to cabbage and allied crops are Black Rot (*Xanthomonas campestris*), Light Leaf Spot (*Gloeosporium concentricum*), Canker or Stem Rot (*Phoma lingam*), while the Soft Rot which has occurred amongst Cornish crops of broccoli and due to the action of a bacterium, *Bacterium carotovorum*, is probably quite common, and is thought to be a secondary condition arising out of some mineral deficiency (e.g. boron). Virus diseases have become prominent in *Brassica* crops in recent years.

BEANS: DWARF AND RUNNER. Halo Blight (*Pseudomonas phaseolicola*) is now a recognised disease of beans in Britain; it has assumed a position of such importance that the growing of less susceptible varieties is often recommended as the only way of dealing with the trouble. Mosaic, caused by one of the plant viruses, produces symptoms of stunted growth and general degeneration in stocks of kidney beans, mostly the dwarf varieties. It also attacks Runner beans, and is one of the virus diseases definitely known to be transmitted in the seed. Anthracnose (*Colletotrichum Lindemuthianum*) may often cause considerable losses amongst both dwarf and runner beans in cold, wet weather. It attacks plants in both the seedling and fully developed stages and damages the pods.

BEANS: BROAD. Chocolate Spot, once regarded as of bacterial origin, is now known to be due to attacks of strains of *Botrytis*.

It is a debilitating trouble and often causes much dama the foliage of broad beans. Spring-sown crops seem less p to attack.

Red Beet. Seedlings of beetroot often develop what is te "Black leg", the trouble being due to one of several soil fi organisms or their combined effect. *Phoma Betae*, *Pythiu* and *Aphanomyces laevis* have all been identified, though *P. Betae* is most commonly associated with this malady. Form Heart Rot, which may appear in stored beetroot, are so times associated with attacks of *Phoma Betae*, but in the r are caused by physiological conditions of the tissues du faulty soils, such as those suffering from trace element c ciency—boron in particular. Red Beet is also attacked by Beet Eelworm (*Heterodera Schachtii*) causing the condi known as beet-sickness, and by a foliage Rust caused *Uromyces Betae*.

Carrots. The only disease of carrots worth noting is Scle tinia Rot, caused by *Sclerotinia sclerotiorum*, which sometu causes rotting in storage. Violet Root Rot, sometimes cal Blue Nose by growers, is caused by *Helicobasidium purpure* and can render roots wothless. Black Rot (*Alternaria radicin* has been identified in Britain in recent years.

Celery. Leaf Spot (*Septoria Apii-graveolentis* and *Septo Apii*), the most serious trouble of celery, is not only capable causing a complete crop failure, but is a disease that appe regularly. It is controlled by spraying. Root Rot (*Phy apiicola*), attacks the roots of both seedlings and adult plan Soft Rot (*Bacterium carotovorum*), which causes a soft brow rot of the hearts of celery, so rendering the heads quite worthl for market, is usually secondary to insect or animal damage.

Lettuce. Grey Mould (*Botrytis cinerea*), is probably t most serious disease of lettuce and most prevalent in col wet weather. It may be particularly troublesome among glasshouse and frame crops where close attention to cultur detail is not observed. Some varieties are less susceptible t attack by *Botrytis* than others, and these should be grow where Grey Mould is troublesome. *Golden Ball*, *Blackpool* an *Cheshunt Early Giant* are examples. Downy Mildew (*Bremi Lactucae*), is a troublesome but sporadic disease both among

outdoor crops and under glass. There are two strains of Downy Mildew, and one of them infects certain varieties only, but the other infects all varieties. Mosaic, a virus disease, also attacks outdoor crops of lettuce. Ring Spot (*Marssonina Panattoniana*), causes rusty markings on outdoor crops of lettuce.

MINT. Rust (*Puccinia Menthae*), is a common disease of cultivated mint and often develops into a major problem. An annual re-infection occurs from spores from the infected crop of the previous year.

ONIONS AND LEEKS. Smut, caused by *Urocystis cepulae*, is a not very prevalent onion disease which attacks the seedlings. The fungus lives on in the soil. Downy Mildew (*Peronospora destructor*), is the well known onion mildew that often becomes prominent in July and August and can seriously reduce the yield. White Rot (*Sclerotium cepivorum*). attacks and destroys the roots and bases of onion bulbs, and shallots. Neck Rot or Storage Rot (*Botrytis Allii*), is often very prevalent amongst stored onions.

PARSNIPS. The only serious trouble, "canker", or rusty brown cracks in the roots, is held to be due not to the activity of any organism, but to faulty methods of culture or result of injury by soil larvae.

PEAS. Leaf and Pod Spot in peas is now attributed to two different species of *Ascochyta* and to *Mycosphaerella pinodes*. One of them, *A. Pisi*, is known to be capable of killing seedling plants outright if the seed was badly infected to start with. Poor stands of peas when sown early are often due to pre-emergence damping-off, caused by *Pythium* spp., etc., and can largely be avoided by seed treatment with organo-mercury compounds or with cuprous oxide. Foot Rot, which causes young plants to go off is due to attacks of *Fusarium* spp.

Marsh Spot is now known to be due to manganese deficiency. Downy Mildew (*Peronospora Viciae*), often prevalent on late crops of peas, seldom does extensive damage. Mosaic, due to plant virus, is also a trouble in peas of some consequence.

POTATOES. The most destructive disease of the potato crop is Blight (*Phytophthora infestans*), which is sunstantially controlled by spraying with a copper fungicide or by dusting with a

fungicidal powder of similar composition. Virus diseases—Mosaic and Leaf-Roll and Virus X—are the cause of degeneration in potato stocks, rendering seed production a matter for special measures.

Wart Disease (*Synchytrium endobioticum*), is a destructive disease which attacks certain varieties only. The remedy lies in growing immune varieties of which there is a large number.

RHUBARB. Crown Rot (*Bacterium rhaponticum*), once promised to develop into a major disease of rhubarb in many parts of the country, especially in the Leeds district, but has declined somewhat because of better crop rotation and hygienic methods of culture.

RADISHES. Radishes, although subject to the same diseases as attack turnips, are seldom seriously damaged.

SHALLOTS. A virus disease of shallots, which weakens the plants considerably, is on the increase. The safeguard is to plant virus-free stocks or to inspect the crop from which the planting cloves are drawn.

SPINACH. Downy Mildew of spinach, caused by *Peronospora effusa*, sometimes causes serious damage to the crop.

SEAKALE. This crop is comparatively healthy, but Black Rot, Soft Rot and Violet Root Rot of the roots have appeared from time to time.

TURNIPS. Like other members of the *Brassica* family, turnips are attacked by Club Root. It is the crop's worst disease and on lime-deficient soils often results in a failure. Turnips are also subject to several types of root rots known respectively as Black Rot (*Xanthomonas campestris*), Soft Rot (*Bacterium carotovorum*), and Dry Rot (*Phoma lingam*). Brown Heart is caused by boron deficiency.

TOMATOES. Blight (*Phytophthora infestans*), can cause a great deal of damage to outdoor crops of tomatoes, especially in the south and south-west, damaging both foliage, stems and fruit. Spraying with a copper fungicide (e.g. Bordeaux Mixture) is the effective remedy. Stem and Fruit Rot (*Didymella Lycopersici*), has become very prominent again in recent years. The remedy is clean seed saved from healthy crops and the use of fresh land for the crops, as the soil becomes contaminated.

VEGETABLE MARROW. Powdery Mildew (*Erysiphe Cichoracearum*), attacks the growing plants in the open and is capable of doing damage. Mosaic, a virus desease, is becoming more prevalent and is often the cause of poor cropping plants.

Insect and Animal Pests of Vegetable Crops.

While the list of insect and other pests attacking vegetable crops is not so formidable as that comprising the fungi, bacteria and plant viruses, the damage inflicted by pests is often very severe and at times wholly destructive to plant life.

ALL VEGETABLES are attacked by wireworms, the larvae of certain species of beetles (*Agriotes* spp., etc.). The wireworms live in the soil, and the damage mainly occurs when the plants are in the young stage.

Slugs are often troublesome, but are easier to deal with than wireworms.

MOST VEGETABLES are also attacked by cutworms, the caterpillars of certain moths (*Agrotis* spp.). The cutworms move either on or very near the surface of the soil, the young and partly-grown plants being the most damaged. Young plants are sometimes damaged by leatherjackets, the grubs of Crane Flies, especially on land mewly ploughed from grass. Peas, beans, potatoes and some other vegetables are attacked by millipedes.

A FEW VEGETABLES, notably the potato, are attacked by eelworms, and such attacks may become serious if the crops are grown too frequently on the same land. Rotational cropping is the best safeguard against this trouble. The Stem and Bulb Eelworm (*Anguillulina dipsaci* Kuhn), is the one usually found attacking vegetable crops, mainly potatoes, onions and occasionally carrots. There is no satistactory remedy, once the soil becomes infected, beyond changing the crops.

BRASSICA CROPS. Various members of the cabbage family are attacked by a large number of insect pests.

Flea Beetles (*Phyllotreta* spp.), attack the seedlings both above and below ground, and inflict serious damage. The Cabbage Aphis (*Brevicoryne brassicae*), attacks all crops, especially brussels sprouts, and can partially destroy the crop if unchecked. The Cabbage White Fly (*Aleurodes brassicae*),

although not so destructive as aphis, has also developed into a pest of major importance. The Cabbage Root Fly (*Chortophila brassicae*), is very destructive in some districts, especially to cauliflower crops. The Cabbage White Butterflies (*Pieris* spp.), have long been known as a serious pest in private gardens, but field crops are not usually so badly attacked. Other pests of *Brassica* crops are the Cabbage Moth (*Mamestra brassicae*) the Swede Midge (*Contarinia nasturtii*), and the Turnip Gall Weevil (*Ceuthorrhynchus pleurostigma*). The Blossom Beetle (*Meligethes aeneus*), is a pest of seed crops.

The wood pigeon often damages crops of Brassicas during the winter months when other food is scarce.

LEGUMINOUS CROPS. The Pea Moth (*Cydia nigricana*), is the principal pest of peas and the cause of maggoty peas. Pea Thrips and the Pea Midge (*Kakothrips pisivorus* and *Contarinia pisi* respectively), often cause much damage to the growing plants. The Root Eelworm (*Heterodera schachtii*), damages the roots of pea plants, and the Pea and Bean Weevils (*Sitona*, spp.), attack the foliage of the young plants. The Black Aphis (*Aphis rumicis*), is the chief pest of Broad Beans, but some damage is often done by the Stem and Bulb Eelworm (*Anguillulina dipsaci*). The Bean Beetle (*Bruchus rufimanesu*), damages the seeds of broad beans.

CELERY. The Celery Fly (*Acidia heraclei*), is frequently the cause of much damage to the foliage of celery as well as parsnips. The larvae of the Carrot Fly also attack the roots of celery occasionally.

CARROT. The Carrot Fly (*Psila rosae*), often inflicts severe damage on carrot crops, the maggots attacking the roots below ground. Aphides (*Cavariella* sp.) also attack the foliage of carrots.

LEEKS. The Leek Moth (*Arolepia assectella*), a French pest, has recently made its appearance in England, particularly in the south and south-eastern coastal counties.

LETTUCE. Lettuce are attacked by Wireworms, Millipedes and Leather Jackets below he soil, and the foliage is attacked by the Lettuce Aphis (*Myzus lactucae*). The roots of lettuce are also attacked by the Lettuce Root Aphis (*Pemphigus bursarius*)

ONIONS. The Onion Fly (*Hylemyia antiqua*), occasionally causes much damage to commercial crops of onions, the maggots attacking and destroying the young plants near the roots. The best remedy is to change the land used for the crop as frequently as possible.

POTATOES. The Colorado Beetle (*Doryphora decemlineata*), is the most serious insect pest of the potato crop, but happily has not yet gained a foothold in Britain, though prevalent on the Continent and in North America. Potato Root Eelworm (*Heterodera schachtii*), is the most serious eelworm attacking potatoes and is the cause of land becoming "potato sick". Some damage to growing crops is occasionally done by the Rosy Rustic Moth, the larvae of which mine or burrow in the stems of the plants.

ASPARAGUS. The Asparagus Beetle (*Crioceris asparagi*), attacks the shoots and foliage of asparagus. The Asparagus Fly has appeared in a few places in England.

WATERCRESS. The Mustard Beetle is predatory on cultivated watercress and often does much damage.

Major Pests and Diseases and Methods of Control.

Animal Pests.

SLUGS. Slugs are very troublesome animal pests and often inflict much damage on growing crops, particularly young plants that may be crippled beyond recovery by attacks. Damage both below and above ground is done by these pests.

Three species of slugs are known to be concerned in crop damage. The Grey Field Slug (*Agriolimax retivulatus* Mull.), occurs generally and attacks particularly the stems and leaves of young peas and beans.

The Small Black Garden Slug (*Arion hortensis* Fir.), is very troublesome in market gardens, feeding both below and above ground, and is injurious to young plants of lettuce and brassica crops and seedlings of peas and beans. It also eats into roots of carrots, parsnips and turnips, and disfigures the stalks of celery.

The other slugs mostly encountered in market gardens in or near towns are the Keeled Slugs, larger creatures with a line

or keel along their backs. They can do much damage by feeding underground on potatoes carrots and bulbs, and on the surface by eating seedlings or dragging them below ground.

The Large Black Slugs, often prevalent, do less damage than the others.

In general, slugs tend to be more troublesome where the land is badly drained, wet and heavy, or is over-charged with organic matter accompanied by acidity. Thus the grower can do something to guard against attacks by maintaining a healthy well-cultivated soil and hygienic conditions generally.

The most effective method of controlling slugs is the use of a poison bait. Arsenical preparations, such as Paris Green, are not safe to use on a field scale. Metaldehyde is both safe and effective when properly used. This substance, in the solid fuel proprietary preparations, is sold in the form of sticks or tablets, which are crushed and mixed with bran at the rate of 1 oz. to 3 lb. of bran. It is also available in packets. The mixture is moistened to render it slightly damp and is then laid along the rows in little heaps of about an egg-cupful each. The mixture may also be used dry and in this condition could be laid with a machine between the rows.

Some measure of control has also been obtained with lime, soot and naphthalene, and powders containing creosote. Ground copper sulphate mixed with lime or kainit, and used as a surface dressing, or, if fine enough, applied with a dusting machine, has also given useful results: 1 lb. of dust is sufficient for 500 yd. of crop row on a field scale. As a surface dressing, 10 lb. of finely-divided crystalline copper sulphate with 1 cwt. of ground kainit are broadcast on the surface in the evening when the slugs are on the surface, this amount being sufficient for ½ acre.

Snails. Snails damage crops in much the same way as slugs, though they usually feed on the portion of the plants above ground. In wet seasons snails can do considerable damage, feeding mostly at night. The commonest species is the Large Garden Snail (*Helix aspersa* Mull.), which has a large grey-brown shell. The other snails doing damage are smaller. The Strawberry Snail (*Hygromia striolata* Pfeiff.) and the Banded Snail (*Helix* spp.) are commonly encountered in cultivated crops.

Snails may be controlled by means similar to those used for slugs, the poisoned bait method (metaldehyde and bran) being equally effective for both pests. The protective dressings advised for slugs are, however, not nearly so effective in controlling snails, though soot and lime is a useful repellent substance when sown between the rows or around the plants. The trouble is that these soil dressings soon lose their effectiveness in showery weather, and need frequent renewing.

Insect Pests.

FLIES. Several species of flies are notorious as much for the harm they do to vegetable crops as for the difficulty that has been experienced in finding effective methods of control. The most notable are the Carrot Fly, the Onion Fly, the Cabbage Root Fly and the Celery Fly. If the infestation is intense the first three may be completely destructive of crops, while the fourth, a leaf-miner, cripples the health of the plants by attacking the foliage.

The Carrot Fly or Carrot Rust (*Psila rosae* Fab.). Though the fly will also attack celery and parsnips it mainly attacks carrot, the attacks becoming intensified in market gardens because of the difficulty of moving the crop further afield each year. For that reason farm crops tend to be less troubled.

This small fly, about 1/5th in. long, overwinters in the soil as a pupa, emerges in the spring or early summer and lays eggs in the soil close to the growing plants. The yellowish-white maggots burrow in the tap-roots so rendering them unfit for market. It damages parsnips in a similar way, and celery by eating the roots. If often remains in the carrots after lifting, and continues the damage in store. Indication of attack is revealed by the tops yellowing off prematurely.

The best control measures are of a preventive nature. First, rotations should be arranged so that carrots are neither grown frequently on the same land nor grown adjacent to infested land. Second, as the pest operates by its olfactory sense very largely, the crop must be disturbed as little as possible. Thinning is inadvisable as this leaves open spaces and cracks in the soil for the fly to enter, besides creating an odour in the air. Seed should be sown thinly to avoid thinning. Early crops should be cleared at one pulling and not be thinned. Powdered or flaked

napthalene and whizzed napthalene when laid along the rows at 10-day intervals (2 oz. per sq. yd.) has been used successfully as a preventive, but though suitable for small areas, is hardly practicable on a field scale. The new insecticide DDT is proving a useful insecticide against many kinds of flies, and there are indications that wettable forms can be used successfully against the Carrot Fly. Two sprayings with an interval of a fortnight, are necessary, treating the hedge bottoms, banks, headlands and ditches, as well as the crop in the field. By skilfully timing sowings it is possible to 'dodge' the Carrot Fly to some extent. Thus, June sowings are often successful.

The Onion Fly (*Hylemyia antigua* Meig.). The life of this fly, which resembles the common house fly in appearance, is similar to that of the Carrot Fly. Overwintering in the soil, the latter may become so infested with numerous pupae that onion growing becomes impossible. The dull-white maggots, which emerge from eggs laid in spring and early summer, burrow into the base of the onion plant where they feed and so destroy the plant. There are two or three broods in a season, which is an added difficulty.

Like the Carrot Fly, this is a most difficult pest to control, and the most practical remedy is to maintain a close watch for attacks and move the crop to fresh land remote from the infested site. Attacked plants should be drawn out carefully, leaving no maggots behind, and be burnt promptly. Repellents, such as napthalene, have been shown to be effective, and the use of a 4 per cent calonel dust, dusted along the rows when the seedlings are 2 in. high, has also been found effective. It is possible that DDT formula will be devised for use against this fly, but no experimental data are yet available. Treating the seed before sowing with an equal weight of calomel dust has been found at Cambridge to provide an effective means of control for this peat.

Experienced onion growers hold the view that drilling parsley with the onion seed or singly between the onion rows is effective in keeping Onion Fly away by masking the scent of the onions. Lastly, it should be noted that autumn-sown and transplanted crops are seldom seriously attacked, and this method of growing the crop is to be recommended where the pest is much in evidence.

The Celery Fly (*Acidia heraclei* L.). The maggot of this fly (which is very small, tawny-brown with iridescent wings) burrows or mines in the tissues of celery and parsnip leaves so causing the characteristic blisters of a leaf-miner's activity. Badly-attacked crops fail to develop satisfactorily, and when young plants of celery are attacked in the seedling beds they are less likely to transplant successfully.

The maggots hatch from eggs deposited in or on the foliage from April to early July by the flies that have overwintered as puparia in the soil. Each female fly may lay upwards of 100 eggs. There are usually two broods in a season, the first doing damage and producing the second brood, the puparia of which remain in the soil for the winter. The life cycle of this fly follows closely that of the other fly pests of vegetables.

This pest is difficult to control by direct attack, and the best course is to avoid attacks in the field by changing the land for celery and parsnip crops, and not placing the crops in close proximity to land where the pest has occurred.

Under seedling bed conditions chemical and other deterrents used as dusts and sprays, may be employed, and the larvae within the leaves may be killed by spraying with a nicotene-soft-soap solution.

The Cabbage Root Fly (*Chortophila brassicae*, Bouche.). This fly, also resembling the house fly in appearance, attacks all crops of the cabbage family, including rad shes, swedes and turnips, in a similar manner to that of the Carrot and Onion Flies, infesting the root portions, so causing wilting and collapse of the plants. It has also been equally as difficult to control. The flies, which overwinter in the soil as pupae, emerge about the end of April or early in May, and from their eggs, which are deposited in the soil close to the main stems of the plants, cream coloured maggots hatch in a few days and begin their attack. There are two and possibly three broods of flies in a season. Several maggots may attack a single plant, the usual symptoms of attack being a sudden flagging, due to interference with water supplies via the roots, and a bluish tinting of the leaves. Growth is also slow or ceases entirely.

As with the other two flies, there is no remedy for saving plants once they are infested, so that control measures are mainly of a preventive nature. On a small scale, tarred felt

discs have been effective in preventing the flies from placing their eggs close to the plants, and a naphthalene preparation applied around the plants also prevents attack by acting as a deterrent. Experimental work at Cambridge in 1938 showed that the root systems of *Brassica* plants, such as cauliflower and Brussels sprouts could be protected from attack by applying a 4 per cent calomel dust to the soil around the bases of the plants. The rate of application equalled 45 lb. per 4,840 plants, but better results were obtained with Brussels sprouts when two light applications were given, i.e. 30 lb. per 4,840 plants. DDT, as a wettable or dry formula, has been found to be an effective insecticide when used as a powder in which the moistended roots of the plants are dipped before planting. All attacked plants, together with the maggots, should be removed and burned, and infested land should not again be used for brassica crops for several years. Several 'natural enemies' are known to prey on the puparia of this fly in the soil, notably species of the black rove beetles.

Beetles and Weevils. The most destructive of the beetles are the Flea Beetles and the Click Beetles, the first doing most of their damage as adults and the latter as larvae, i.e. the well-known wireworms. The Turnip Gall Weevil attacks the roots of *Brassica* crops causing malformations resembling Club Root which tend to mar turnips and swedes.

Flea Beetles. Several species of these very small beetles, principally *Phyllotreta* spp., sometimes referred to as "Turnip Fly", attack all the crops of the *Brassica* group, doing most damage in the seedling stage. Other crops, including potatoes, may also be attacked.

These beetles overwinter as adults in hedge bottoms, beneath refuse, etc and, emerging in the spring, promptly attack any plants of the cabbage family available, including germinating seedlings of newly-sown crops both below and above ground. Eggs for the next generation are laid in the June-August period, and the larvae from these also feed on crop plants, until they pupate and in turn become the beetles which will overwinter, the whole metamorphosis taking about 6 weeks.

Fortunately, both Derris and DDT preparations have been found to provide effective controls for Flea Beetles. Both substances are most effective when used as dusts applied by

means of a blowing machine (of which there are several makes on the market) at the rate of from 35 to 50 lb. per acre according to the intensity of the attack. Nicotine dust is also effective when used in warm weather.

Click Beetles (*Wireworms*). The damage inflicted on crops by wireworms is too well-known to need detailing. The chief beetles responsible are *Agriotes lineatus*, *Agriotes abscurus*, *Agriotes sputator*, and a species of another genus, *Althous*, though others are also concerned.

Wireworms damage nearly all cultivated crops, peas and beans being the least troubled, and the intensity of attack is usually higher on land newly-broken from old pasture. The roots of attacked plants are either damaged so that they die, or damaged so that they are crippled. Tubers of potato crops are are often badly riddled by wireworms.

There are advertised proprietary chemical soil treatments which vegetable growers can use. It is best kept in check by suitable rotations and cultivations, at the same time cropping the land so that the least harm is suffered by susceptible crops. Well-managed market gardens are not so troubled by wireworms as farm lands where leys and pastures are part of the farming system. On a small scale trapping may be successfully practised, by using pieces of potato, beetroot or carrot.

Pea and Bean Weevils. These small beetles, of which several kinds exist in England (the Striped Pea Weevil, *Sitona lineatus* L., is the most common), do damage to leguminous crops by biting out notch-like pieces of the young plants. Under good growing conditions the crop suffers little permanent harm, though the damaged plants are often checked when conditions are less favourable.

The beetles overwinter, using what shelter is available, and emerge in spring to feed on pea and bean crops and lay eggs in the soil. From these emerge white-coloured grubs with brown heads, which feed on the roots of the plants until pupation, which lasts two or three weeks. Thus these weevils are always present in one form or other.

On a field scale, calcium arsenate has given the best results when used as an insecticidal dust. The dust is made up of equal parts of calcium arsenate and powdered calcium carbonate, and should be applied at the rate of about 40 lb. per acre,

preferably when the plants are wet with dew. Calcium arsenate may also be used alone at half this rate. A 5 per cent DDT dust has also been found to give an effective control and is protective against further attacks. Good tilthy seed-bed conditions, and surface tillage of the growing crops, are an assistance in combating this pest.

APHIDES. *Cabbage Aphis* (*Brevicoryne brassicae*, Linn). Certain *Brassica* crops, more particularly summer and autumn cabbage, and Brussels sprouts, are often damaged by attacks of this aphis. The attacks are worse in some seasons than others, depending on weather and other conditions.

This aphis overwinters in the egg stage, the eggs being laid on stems of cabbage and Brussels sprouts remaining on the land. The colonies that develop from the overwintered eggs give rise to viviparous forms that increase very rapidly.

As this aphis is covered with a coat of fine waxy powder, which affords protection from sprays, the best control is obtained with dusts. A 3 per cent nicotine dust applied by blower at 30-40 lb. per acre, when the temperature is 60° F. or over, will give the best control of this pest. It is important to clear away all unwanted plants and old stems, whether stacked in heaps or still on the land, where the eggs can be laid to overwinter.

The Bean Aphis (*Aphis rumicis* Linn.). This well-known pest of broad beans is both widespread and of annual occurrence. It also attacks field beans and certain weeds such as goosefoot. This aphis normally overwinters on the spindle tree (*Euonymus*), as eggs deposited by the last generation of wingless females produced by the migrating winged females. In the spring more females emerge from these eggs and produce young without sexual union. Winged female forms appear in succeeding generations, and these fly to beans and thus give rise to further generations, no males being produced until autumn.

As the tips of the bean plants are attacked first these can be pinched out and destroyed before the attack develops. Though this is seldom wholly successful in contolling the pest, it alleviates the intensity of the attack and also stimulates the productivity of the plants.

Although difficult to use on a large scale, spraying with a nicotine and soft soap solution provides a measure of control.

The plants must be thoroughly wetted. It must be admitted, however, that this pest is difficult to control by spraying or dusting methods.

Cabbage White Fly (*Aleurodes brassicae* Walk.). Crops of autumn cabbage, savoys and brussels sprouts are sometimes infested by thousands of these small white, fly-like insects (they are not flies). Although they do little real damage their presence in the produce is objectionable. Unfortunately, no effective method of control is known, and, as with the Cabbage Aphis, this insect is carried over from season to season on old stems of kales and brussels sprouts, it is, therefore, a wise precaution to get rid of these at the end of the season before the new crops are planted.

BUTTERFLIES AND MOTHS. Only one species of butterfly is seriously predatory on vegetable crops, but two others are known to do damage of a similar character on the same crops. Several species of moths do damage.

Cabbage White Butterfly (*Pieris brassicae* Linn.). Very severe damage is sometimes done to crops of cabbage, brussels sprouts, savoys, kales and other winter *Brassica* crops by the caterpillars of this butterfly skeletonizing the leaves. The pest is too well-known to need describing. It is not generally known that the main damage to crops is done by the *second brood* of caterpillars, the first butterflies having emerged from over-wintering chysalides in spring and early summer and given rise to the second generation that appears from the end of July onwards. The caterpillars of this second generation feed on until frost comes at end of September or early October.

As the usual caterpillar poisons cannot be used on these edible crops recourse must be had to insecticidal substances, such as Derris and DDT, used as wet or dry formulae. It is claimed that a½ 2 per cent DDT dust will give an effective control, though it does not prevent the laying of more eggs. Hand-picking of the caterpillars is feasible on smaller areas. This pest is substantially attacked by various parasitic insects while it is in the caterpillar stage, and this tends to preserve a natural balance. It should be noted that the caterpillars of two other white butterflies, the Green-veined White and the Small White are found in association with the Cabbage White.

The Cabbage Moth (*Mamestra brassicae* Linn.). The cat-pillars of this moth are frequently found feeding on Brass crops in company with those of the White Butterfly, whi they resemble, but unlike the latter, they are found on oth types of crops also, e.g. lettuce, onions, sweet corn and tom toes. This pest's life history resembles that of the Cabba White Butterfly. Moths, which fly only at night, emerge fro chrysalides that have overwintered in the soil. They are seen early as May and, from succeeding generations, as late October.

Control measures are similar to those used against th Cabbage White Butterflies.

Turnip Moth (*Agrotis segetum* Schiff); *Hart and Dart Mo* (*Agrotis exclamationis* L.); and *Yellow Underwing Mo* (*Agrotis pronuba* L.). The larvae of these moths are the des tructive Cutworms, or Surface Caterpillars, which often de damage to vegetable crops by biting through the stems o plants at soil level or just below. They also eat the fleshy part of potatoes, turnips and other root crops. A few other moth of similar life habits are also concerned. The chrysalid stag of these moths is spent in the soil, the first generation of moth emerging from chrysalides between the beginning of June and the end of July. A second generation may appear in August and September, but in any event the larvae are to be found throughout the summer, autumn and winter and early spring feeding whenever the weather is suitable, and mostly during the night.

Hand-picking is possible on small areas, either at night, when the caterpillars are on the surface, or by day by scraping aside the surface soil near the plants to reveal them. The habits of these caterpillars make control by direct attack difficult. *They do not stay on the plants attacked, but spend the day time concealed in the soil or beneath leaves, grass or stones.*

When attacks are discovered on growing crops a harrowing or hoeing of the land is of value by exposing the caterpillars to the attacks of birds. Good results have been obtained by poisoning the caterpillars with a mixture of Paris Green and bran (1 lb. to 20 lb.). This mixture, which is very poisonous to all animal and bird life should, however, be used with every possible care to prevent harm to dogs, cats and fowls.

Pea Moth (*Cydia nigricana* Steph.). This moth is the cause of "maggoty" peas, but does more damage in gardens than in the fields, where a frequent change of cropping tends to exert a control on its extension. The moth which overwinters in the chrysalid stage in the soil where the infested crop was grown, lays its eggs in the blossoms of the plants from June onwards. Later the small dirty-white caterpillars are found in the pods, eating the peas. More harm is done to later-sown crops than early ones.

Hitherto there has been no effective control method for this pest, beyond rotational cropping. Recent experimental work at Cambridge has shown that an effective control can be obtained by spraying the crop at the appropriate time with a ½ per cent DDT emulsion at the rate of 140 gallons per acre. If a field crop should become infested seriously it is a good plan to plough the land deeply after clearing the crop, with the object of burying the chrysalides deeply so that they cannot emerge the following year. Where the pest is prevalent it is inadvisable to grow peas for seed, and crops of green peas should be grown as far as possible from any infested sites.

Pea Thrips (*Kakothrips pisivorus* Westw.). These very small black insects, known as thunder flies, feed on the flowers, pods and haulm of peas and beans and, on peas especially, often do harm to the crops. Crop attacks, which usually take place in May and June, are made by the small orange-coloured larvae, which hatch from eggs laid in the plants by adults that have overwintered in the soil. When the attacks are severe the plants may become stunted and unproductive.

No satisfactory method of control for the thrips has yet been found, though spraying with a nicotine insecticide in the early stages of attack will reduce the numbers of the pest and lessen the severity of the damage. It is possible that a DDT insecticide could be used with some effect against this pest, though no experimental data are available.

Leek Moth (*Acroplepia assectella*). This pest of leeks, onions, shallots and garlic, prevalent throughout Europe, has now appeared in England. The moth, which is very small, ¼ in. long brownish-grey in colour with a white spot on the rear edge of each forewing, passes the winter in the adult stage and lay eggs

on the plants towards the end of April and in early May. The caterpillars, hatched from the eggs in 5-8 days, tunnel into the leaf tissue, feeding between the folded leaves of leeks and in the hollow leaves of onions. In about 3 weeks they are fully fed and enter the pupa stage,the moths emerging during June and July. There are two or three generations of moths in one season.

Dusts and sprays containing DDT have given a good control, success depending on the application being made at intervals and while the caterpillars are still young. A suitable spray formula is 1 ox. nicotine (98 per cent purity) in 10 gallons of water plus a good wetting agent. A dust should contain 4 per cent nicotine and should be applied in warm weather. DDT formulations have also given promising results.

Fungus Diseases.

Potato and Tomato Blight (*Phytophthora infestans*). Blight is the most serious disease of potatoes and outdoor tomatoes, because in both instances it may kill the plants and ruin the crop. The fungus attacks all parts of the plants, beginning on the leaves and stems, where it causes greyish-black spots from which spores spread rapidly to produce fresh infections. Badly infected tubers of the potato and fruits of the tomato decay more or less rapidly, but slightly infected potato tubers carry over the organism to the following year. As far as is known this is the only way in which the disease is carried over from year to year, hence the importance of planting healthy seed potatoes only, and destroying all "ground-keepers" or self-sown plants. The attacks of this disease are much worse in damp, humid weather.

The standard remedy against Blight is spraying with a copper fungicide, such as Bordeaux or Burgundy Mixture or a proprietary compound. Dusting is also practised but is not nearly so effective. Two or more sprayings or dustings may be necessary to ensure complete crop protection, and the first should always be supplied before the Blight becomes evident.

Celery Blight or Leaf Spot (*Septoria* spp.). Celery Blight is the principal disease of this crop and appears in all countries where the crop is grown, its spread being assisted by the fact that the fungus is of a seed-borne type. The malady appears first as small brown spots on the leaves. Later the spots run

together and the whole leaf may assume a dry appearance. Dark lesions on the stems are also formed. Plants badly attacked are crippled so that the crop is spoiled.

As the disease is seed-borne it is very important either to use clean seed or to take the precaution of disinfecting the seed before sowing by soaking it for three hours in a solution of formalin. The growing crops should be regularly sprayed with Bordeaux Mixture or a suitable proprietary copper fungicide to protect it from attack.

Club Root or Finger-and-Toe (*Plasmodiophora brassicae*). This disease affects the root portions of plants belonging to the family *Cruciferae*, particularly the cabbage group of the *Brassica* crops, causing swollen malformations and so depriving the plants of healthy root action. Affected plants are stunted and unhealthy, and may die.

The parasitic organism concerned, a slime fungus (it is not a true fungus), lives in the soil, and can remain dormant for several years in the form of minute spores. On germination, each spore produces a microscopic body that enters the plant through the root hairs and subsequently multiplies greatly and stimulates the development of malformed tissue. The soil is reinfected when the diseased material decays.

In common with all soil parasites, Club Root is difficult to combat. The only satisfactory method of control is to keep it down by maintaining an alkaline soil condition. Regular liming of the land is therefore a precautionary measure. When attacks have occurred the land should be well limed with freshly-slaked or hydrated lime, according to requirements. *The lime should always be in a finely divided state and not lumpy*, and should be well cultivated into the soil. It is necessary to avoid introducing infection, when purchasing plants from outside sources, by dipping the roots of the plants, before planting, in a mixture of calomel dust and water—1 lb. of 4 per cent calomel dust with one-third of a pint of water. A further worthwhile precaution is the raising of plants in sterilized soil, though admittedly this is hardly feasible on a large scale.

White Rot of Onions and Shallots (*Sclerotium cepivorum*). Further experimental work at the Tilgate Horticultural Station, Surrey, has confirmed earlier work which showed that a 4 per cent calomel dust applied to the seed drill at the rate of 1 lb.per

50 yd. drill, gave a substantial control of White Rot in spring sown onions.

Work on transplanted seedlings raised under glass showed that a treatment consisting of dipping the plants, before transplanting in the open, in a paste prepared from 4 per cent calomel dust and water gave a substantial control of the disease. Work on shallots showed that a pre-planting treatment of dipping the bulbs in the paste described gave a significant control of White Rot and also a slight beneficial effect on storage losses.

Insecticides and Fungicides. The following are the principal substance in common use as insecticides and fungicides for controlling pests of vegetable crops, both as wet and dry preparations (sprays and dusts).

Nicotine. As is well known, nicotine is a poisonous and volatile alkaloid of *Nicotiana tabacum*, the tobacco plant. It is an effective contact insecticide against aphides (greenfly), and sucking insects in general, when used either as a prepared spray or as a dust. Commercial nicotine should be of the 95-98 per cent purity standard and be free from pyridine and other active principles. As a spray it is commonly used at ¾ oz. per 10 gal. of water, with the addition of from ½ to 1 lb. of soft soap, or commercial spreader, as a wetting agent. The dust is usually prepared on a basis of from 3 to 5 per cent, using a suitable base. It is easily handled and is effective when applied at the rate of from 20 to 40 lb. per acre, according to crop, on a warm, still day. The temperature should be 60° F. or over to gain the maximum vaporising effect with nicotine dusts.

Calomel. Calomel, the popular name of an insoluble compound of mercury (thereby differing from the other mercuric compound, corrosive sublimate, which is soluble and more dangerous to handle) has been found to be very toxic to the eggs of certain insects. Experimental work at Cambridge revealed that a dust consisting of calomel and a finely-divided and inert base, on a composition of 4 per cent, gave a good control of the Cabbage Root Fly when placed in contact with the eggs. An egg mortality as high as 94 per cent was obtained in the field when the dust was applied around the bases of the plants within 4 days of planting out. The usual rates of appli-

cation are 45 lb. per 4,840 plants in one application (for cauliflowers) and 30 lb. per acre in each of two applications (for brussels sprouts). If pure calomel is obtained it must be mixed thoroughly with a suitable inert carrier, such as dry sifted soil or sand, before use. It is usually applied on the basis of approximately 1 oz. of calomel to 60 plants treated.

Calomel has also been found to act as a soil fungicide. A 4 per cent dust has been shown in experiments to provide a substantial control of White Rot disease in onions and shallots. It can also be used as a seed treatment for celery seed to control Leaf Spot.

DERRIS. Derris insecticides became available as a result of the discovery that the roots of certain species of *Derris*, a genus of Far Eastern plants, were used by the natives as fish poison. The active principle of derris is a complex organic substance known as rotenone. Derris insecticidal preparations, both dry and wet, proved particularly effective in controlling several pests of fruits and vegetables, particularly Flea Beetles on *Brassica* crops. When, with the fall of Malaya in the late war, supplies from the Far East were cut off, search was instigated to find substances to replace derris. This led to the production of DDT and other new insecticides. It should be noted that rotenone is also derived from the genus *Lonchocarpus*, a South American plant, but supplies are limited.

DDT. During the 1939-45 war wider use was made of an insecticide based on dichloro-diphenyl-trichlorethane (known shortly as DDT) after experimental trials with "Gesarol" the original preparation of the Swiss Geigy firm at Basle. This insecticide, both in wet and dry forms, is toxic to all insects; it has proved effective in dealing with some insects, notably those of the Coleoptera (beetles and weevils), Diptera (flies) and Lepidoptera (butterflies and moths) and is not dangerous to man and animals. Known generally as DDT insecticides, differing only in formulation and method of application, these preparations are now generally available. The inert medium employed in preparing the dust or powder forms is usually kaolin. The use of DDT insecticides is becoming fairly general for controlling Colorado Beetle, Asparagus Beetle, Carrot Fly, Mushroom Flies, Cabbage White Butterflies, Leek

Moth and Flea Beetles notable amongst the pests attacking vegetable crops. Recent experimental work has shown that DDT emulsion is effective against Pea Moth. On the other hand DDT had not been found usefully effective against aphides. It is less hazardous to man and animals than arsenical compounds but nevertheless, is harmful and should not be used on crops such as cabbage and lettuce within 3 or 4 weeks of harvesting.

Naphthalene. This greyish-white inflammable substance is obtained by the distillation of coal-tar. Crude naphthalene has been much used as a soil insecticide and also as a repellent to prevent attacks by certain fly pests of vegetable crops. Crude grades of the substance, known as "whitened naphthalene" and "drained creosote salts", are suitable for use amongst crops as well as the powdered or flaked naphthalene. Care must be used to avoid sprinkling the plants with the substance, or scorching may result, particularly in dry weather.

Metaldehyde. This inflammable chemical compound, was originally placed on the market as a solid fuel for domestic heaters in the form of sticks and bars under the proprietary name of "Meta". The discovery that a mixture of powdered "Meta" and bran was not only strongly attractive to slugs and snails but also acted as a rapid poison to them, provided a much-desired effective control for these animal pests. Metaldehyde powders, ready for mixing with the bran, are now sold, and some firms make up the prepared bait. The usual formula for poison bait is 1 oz. of Metaldehyde to 3 lb. of bran or ½ lb. to 25 lb. This substance is dangerous to the health of human beings and domestic animals and birds, if eaten.

Paris Green. Paris Green or Emerald Green, a poisonous compound of verdigris, copper and arsenic, has been much used, mixed with bran, to form a poison bait to control slugs, snails, surface cutworms, caterpillars and leather jackets. The usual formula is 1 lb. of Paris Green to 20 lb. of bran, with enough water added to moisten the mass of the mixture.

Under the Protection of Animals Act, 1911, however, considerable circumspection is required in the use of this substance on open land.

FORMALDEHYDE. Formalin, a 40 per cent solution of formaldehyde in water, widely used as a germicide and food preservative, has been found to be a useful disinfecting agent for seeds and soil. Although it may not be *entirely* effective with seeds, the results obtained reduce infection very considerably. Seed of celery infected with Leaf Spot is treated by steeping for 3 hours in a solution made up of 1 part of formalin in 300 parts of water. The seed should be dried after treatment, particularly if it is to be kept any length of time.

Stronger concentrations are used for sterilizing soils and manures, the usual formula being 1 part of formalin to 49 parts of water.

COPPER AND SULPHUR FUNGICIDES. Copper and sulphur are the two chief fungicidal substances suitable for practical use. Both are prepared for use as wet (spray) and dry (dust) formulations in combination with lime or soda. Thus, sulphate of copper is used with lime for Bordeaux Mixture, and with soda for Burgundy Mixture, or, in combination with finely-divided lime, as a dust. The sulphate of copper should always be of the best quality—98/100 per cent purity—and may be used in either crystal or powder form. Similarly, sulphur is prepared for spraying as a "wettable sulphur", as a compound, e.g. lime-sulphur and liver-of-sulphur and also as colloidal sulphur. Sulphur is also used alone in the dry form as flowers of sulphur and green sulphur and also as a dust in combination with certain inert substances.

Various proprietary preparations of copper fungicides are also marketed and these can be used in place of home-made Bordeaux and Burgundy preparations. There are also sulphur preparations of a similar nature.

PERENOX. Perenox is an example of a proprietary copper fungicide that can take the place of Bordeaux Mixture and Burgundy Mixture for the control of Potato and Tomato Blight, Leaf Spot of celery and certain Downy Mildews. It is a factory-prepared substance containing 50 per cent of copper as cuprous oxide. It dissolves instantly in water and requires no additions before use as a spray.

QUANTITIES OF MATERIAL REQUIRED FOR PEST CONTROL. The following are the approximate quantities of materials required to treat one acre of plants or seed beds :—

	Seedbeds	*Plants three parts grown*
Derris Dust ...	40-50 lb. per acre	50-75 lb. per acre
Naphthalene Dust ...	55-65 lb. per acre	50-75 lb. per acre
Nicotine or other wet sprays : Bordeaux Mixture ...	60 gal. per acre	120 gal. per acre
Calomel Dust ...	1 lb. for every 60 yd. run of seed row	Two applications—30 lb. per acre

EQUIPMENT REQUIRED. The minimum equipment for effective pest control on the average size market garden would be a rotary dust gun, a pressure knapsack sprayer and a hand atomiser. On large concerns small power units of all three types of equipment can be employed. Improvised dusting equipment can also be of a home-made type, e.g. fine-mesh bags fastened to sticks and gently shaken at walking pace will free sufficient dust for practical purposes.

HOW TO MAKE BORDEAUX MIXTURE. This fungicide is usually made by one of two formulae, depending on whether quicklime or hydrated lime is used. As the latter is now commonly available, and easier to use, there is no point in using the other. The usual *quicklime* formula is 8-8-100 (8 copper sulphate, 8 quicklime and 100 water, all parts by weight), though some prefer the 8-10-100 formula. With the *hydrate of lime* the lime is used at the rate of half as much again, and the formula becomes 8-12-100.

Two wooden tubs are necessary (metal vessels should never be used), one to contain the stock solution of copper sulphate (bluestone), which is prepared by dissolving the bluestone in water on a basis of 1 lb. to 1 gal. The bluestone should be suspended in the water by means of ordinary sacking.

To prepare the mixture the hydrated lime is either stirred into the appropriate quantity of water or it may be "creamed" separately in another vessel in a little water to begin with, and then be added to the spray mixing tub for further dilution. This method gives the better suspension. The stock solution of bluestone is then added to the lime solution, a gallon at a time, as required to balance the formula for the quantity of lime

water, and the mixture is well stirred at the same time. The mixture should be used freshly-made and should not be stored.

An important advantage derived from the hydrated lime formula is that there is very little grit, giving less wear and tear of spraying equipment and fewer stoppages of spraying work due to obstructions. Hydrated lime is procurable from all builders' merchants, packed in paper bags of a handy size.

Burgundy Mixture is made by substituting washing soda (sodium carbonate) for the hydrated lime in the same proportion.

TRACE ELEMENT DEFICIENCIES. A deficiency of one or other of the so-called trace elements or minor nutrients is not infrequently the cause of trouble amongst certain crops, which develop symptoms resembling a diseased condition. Formerly trace elements were supposed to be present in most cultivated soils in sufficient quantities for the needs of crops, but experimental work has now shown that this is not always true.

Boron Deficiency. This deficiency causes heart rot in beet and celery, brown rot in turnips, and curd-browning in cauliflower —which is usually preceded by brown patches in the stem of the plant and in the branches of the curd. Curds so affected are of bitter taste when cooked. Boron deficiency also causes a lack of colour in lettuce.

Experiments at Cornell University revealed that the application of 10 lb. of borax per acre when mixed with the ordinary fertilizer and worked into the soil before planting, successfully controlled browning due to boron deficiency. An application of pulverized borax between the rows and cultivated in also checks the browning symptoms from developing after they have initially appeared in the stems.

The possible effect of boron might be tried out on any unhealthy or unthrifty crop, for borax is both cheap and easily applied. As a general rule improved crop growth is noticeable even where no symptoms of deficiency have developed. There is no need to exceed a rate of application of 10 lb. per acre for such treatment.

MANGANESE DEFICIENCY, ETC. Not only a *deficiency* of this element but a *disturbed inter-relationship* between it and other nutrient elements in the plant will induce symptoms resembling

a diseased condition. Marsh Spot of peas is now known to be caused by manganese deficiency, and occurs, for example, on rich fenland soils where low exchangeable manganese occurs with a high level of nitrifiable nitrogen. In field tests the application of managnese sulphate to marshy soils before sowing has reduced Marsh Spot significantly. Applications of 100 lb. per acre are recommended, where manganese deficiency troubles occur. Many vegetable crops, including all the *Brassica* crops, beans, red beet, parsnips, onions, lettuce and potatoes, react to manganese deficiency in the plant stage, but the Marsh Spot symptoms occur in the *seeds* of peas and beans.

Disease Control by Warm Water Treatment

Sometimes, when a disease of plants cannot be controlled by spraying or dusting the growing crop with a fungicidal preparation, other methods may be possible. An example is Mint Rust which can be controlled only by warm water treatment of the dormant rhizomes or runners, as they are lifted from the open land in the autumn before being used for forcing.

The treatment is 100 per cent effective if properly carried out. The water in the bath or copper should be heated to about 112°F. but *not above* 115°F. or lower than 105°F. The runners should be cleaned by hosing with cold water and are given ten minutes treatment in the warm water. After removal they are again hosed with cold water. Not only is the Rust disease controlled, but the treated runners produce a luxuriant growth. A reliable thermometer should be used for ascertaining the water temperature.

As stated on p. 99, Canker in the *Brassica* crops can be controlled by treating the seed in warm water at a temperature of 122°F. for about 20 minutes.

APPENDIX I.

Grading and Packing. Principal Containers for Market Produce. Storage of Vegetables.

The aim of the grower of fresh vegetables should be to present an attractive, well-graded and honest pack. It is the only way in which to build up a sound trade connection. Buyers are attracted to imported, e.g. Dutch, produce largely because of the better class and presentation which is the rule rather than the *exception*.

Efficient crop handling should go hand in hand with efficient crop production. The full value of well-grown crops is often not reaped by the grower because his marketing methods are out-of-date. The grower should make use of modern handling equipment and standardised market packages. The crating, boxing and bagging of vegetables whether done in the field or in the packing shed call for properly designed grading table and packing bins, which can be made quite easily at home. Grading tables for roots and bulbs should consist of two pieces—a tipping table and a sorting table—both fitting up to form one unit. The top of the sorting table should always incline towards the packer and should be slatted to allow loose skins and loose soil to fall through.

For trimming and packing all crated or bagged Brassica crops always use a properly designed table consisting of a receiving bin, trimming boards and a packing bin all in one unit. Although each packer can work from the same bin each should have a packing stool on which the crate or box stands while being packed. The bottoms of both bins should consist of loosely-hung sacking. If made of light but strong timber

well fastened together these bins can be moved from field to field and set up where required for work. It is impossible to grade and pack efficiently without good tables. With them it is surprising how rapidly the work of grading and packing proceeds.

Principal Containers.

Bags. Used chiefly for potatoes, root and green vegetables and holding from ½ to 1½ cwt. according to nature of produce. Dimensions: 39 in. long × 27 in. wide. When used for cabbages the count is used instead of weight.

Half-Bags. Used for peas, beans, brussels sprouts, onions and also root vegetables. Holds 40 lb. of peas, runner beans and broad beans; 28 lb. of sprouts; 56 lb. of onions and other roots. Dimensions: 34 in. long × 18 in. wide.

N.B.—Specially made, open-mesh, net bags are used for onions and brussels sprouts to allow of adequate ventilation of the produce; when used for the latter the weight is usually 20 lb. or 40 lb.

Boxes, Non-Returnable. Tomato Box, holding 12 lb.; dimensions 14 in. × 9 in. × 5½ in. Half Tomato Box, holding 6 lb; 11 in. × 7 in. × 4½ in. Also used for forced vegetables, such as seakale and Witloof chicory.

Bushel Box, used for a variety of purposes; dimensions, 19¾ in. × 13¾ in. × 10 in., with corner posts.

Two-Bushel Box; dimensions, 27½ in. × 17 in. × 12 in.

Pot Box; dimensions, 18½in. x 14¼in. x 12½in.
Half-Pot Box; dimensions, 15in. x 11¾in. x 10in.
Note: Pot and Half-Pot *crates* are also used with similar dimensions.
Small Wooden Box for selected grades of sprouts; dimensions, 14in. x 9in. x 5½in.

Boxes: Returnable. Bushel Boxes; dimensions, 19¾in. x 13¾in. x 10in. Two-Bushel Box; 27½in. x 17in. x 12in. Strongly made and clamped at corners, and used for a variety of purposes. Cheshire Box; dimensions, 30in. x 21in. x 6in. (with corner posts, 7in.).

Chip Basket. Chip Basket, of both wood and strawboard construction, is used for tomatoes, mushrooms, forced beans, watercress and the choicer produce.

Crates: **Non-returnable.** National Broccoli Crate, with horizontal slats; internal dimensions, 22⅞in. x 13¾in. x 13¾in. with corner pieces.

Large Lettuce Crate; dimensions, 22½in. x 16½in. x 9in.
Standard Lettuce Crate; dimensions, 22¾in. x 14½in. x 9in.
Small Lettuce Crate; dimensions, 20in. x 13in. x 8in.
Celery Crate; dimensions, 18in. x 15in. x 4½in.

Asparagus Crate; dimensions, (for 12 bundles), 21in. x 12in. x 6in.; dimensions (for 6 bundles), 21in. x 12in. x 3½in.
Rhubarb Crate; dimensions, 28in. x 11¾in. x 7⅛in.
Pot Crate; dimensions, 18½in. x 14¼in. x 12½in.

Flat. A wicker basket with lid. Dimensions, 21in. x 16in. x 10in. Used, mainly for cucumbers and watercress.

Sieve Bushel. A round wicker basket. Diameter, 17in. Depth at side 10½in. Depth at middle, 9in.

Sieve Half. A round wicker basket. Diameter, 14½in. Depth at side, 9in. Depth at middle, 7½in.

Pot. A rectangular wicker basket. Dimensions, 20in. x 13in. x 14in.

Strike. A wicker cross-handle basket approximately 12in. in diameter and 7in. deep.

Punnets. Usually made from chipwood and of varying sizes. Seakale punnets are 8in. in diameter at the top, 7½in. at the bottom, and 2in. deep.

The square punnet for mustard and cress is of 18 cu. in. capacity, and is sometimes made of strawboard.

N.B.: The dimensions given for the various boxes and crates are inside measurements.

Storage of Vegetables. The crops usually stored for several months after harvest are onions, shallots, potatoes, carrots, turnips, red beet, pumpkins and marrows. Storage in the field is usually the method applied to potatoes and root crops, but it must be admitted that it is not wholly satisfactory. Storage in trenches, pits or surface mounds covered with straw and soil has many disadvan ages, not the least of which is that the produce is exposed to fluctuations of temperature and moisture. The American system of storing these crops in specially-designed storage houses has much to commend it.

For root crops, which need a relatively high humidity, storage cellars, specially built in the open, are best, but the temperature should range from 32° to 40° F. to give the maximum storage period.

Onions and shallots need a cool *dry* atmosphere with plenty of ventilation, and this crop calls for a specially constructed store house.

Potatoes, similarly, are best stored in properly-constructed buildings where the temperature, both as to maximum and minimum readings, can be controlled. They should not be exposed to a temperature at or below the freezing point in any circumstances, yet they need more ventilation than clamp-storage affords.

Pumpkins and marrows need a dry, fairly warm building for storage, and the temperature should not fall below 40°F.

Vegetables of all kinds can be held for varying periods in cold storage where the temperature is reduced to a low point (minimum 32° F.) by refrigeration. This is very suitable for fresh perishable produce.

APPENDIX II.

Fertilizers for the Vegetable Grower

In addition to the large number of compound fertilizers of a proprietary character there is normally available a wide range of organic materials and "straight" chemical substances which can be employed to increase soil fertility. As a rule these materials, of which a selected list follows, supply only one of the three main plant nutrient elements, nitrogen, phosphorus and potassium, but there are available a few materials that furnish one of more elements. In recent times supplies of these commodities have become restricted, and with the exception of sulphate of ammonia, are in short supply. Potash, particularly, is scarce and should be carefully used. The concentrated granular type of fertilizer now being marketed is extremely useful as it reduces bulk handling.

Nitrogenous Fertilizers: (a) Rapidly Effective.

1. *Nitrate of Soda.* Usually of 95 per cent. purity and containing 15·5 per cent. of nitrogen. Inclined to render the heavier soils more sticky and wet.
2. *Sulphate of Ammonia.* Usually of 97 per cent. purity and containing 20·6 per cent. of nitrogen. The modern synthetic product is claimed to be neutral while the old gas works product was often of an acid character.
3. *Nitro-Chalk.* One of the best forms of quick-acting and effective nitrogenous fertilizers. This material is a compound of nitrogen and lime (calcium carbonate) and should contain about 15 per cent. of nitrogen.
4. *Calcium Cyanamide.* Also a substance with a lime base usually containing about 20·5 per cent. of nitrogen. Slower in action than the three preceding. Being hydroscopic it must be kept very dry to preserve its condition.
5. *Nitrate of Potash.* A valuable material providing about 14 per cent. of nitrogen and 46 per cent. of potash. The potash is combined with the nitrogen to form a soluble nitrate.
6. *Soot.* Contains a small amount of nitrogen as sulphate of ammonia, the latter ranging from 1 to 6 per cent. according to derivation, etc.

7. *Dried Blood.* A valuable organic fertilizer varying in nitrogen content from 6 to 16 per cent. It decomposes quickly so belongs to this class of rapid-acting fertilizers.
8. *Urea.* A synthetic product was formerly made in large quantities in Germany and sold under the trade name of "Calurea." It contained about 34 per cent of nitrogen some of which was in nitrate form. Straight urea contains up to 48 per cent. nitrogen and is a valuable fertilizer.

NITROGENOUS FERTILIZERS: (b) SLOWLY EFFECTIVE.

1. *Hoof and Horn.* An organic material prepared in varying degrees of fineness and possessing varying amounts of nitrogen, usually from 12 to 14 per cent. Sometimes mixed with bone meal to form a nitrogenous-phosphatic fertilizer of slow action.
2. *Shoddy.* Considered by many practical men to be the best substitute for farmyard or stable manure or compost, from 1 to 2 tons, according to analysis, being used in place of 1 ton of the latter. Varies greatly in nitrogen content, normally from 5 to 14 per cent according to grade.
3. *Other Materials.* Skin waste, feathers, hair and fur waste, leather dust and treated sewage, are all materials that supply nitrogen in a slowly-acting form, but should always be purchased on analysis.

PHOSPHATIC FERTILIZERS.

1. *Superphosphate.* Several grades are made, but that usually on offer contains 18 per cent. of soluble phosphoric acid (P_2O_5). The most effective phosphatic fertilizer available, but for effective action lime must be present in the soil. A concentrated form known as triple superphosphate is now on the market.
2. *Serpentine Superphosphate.* A new type of neutral superphosphate made by mixing the latter with finely-ground and dried serpentine rock. It is claimed that the magnesium in the rock both neutralises and converts the water coluble P_2O_5 of the superphosphate to a form more readily available as a plant nutrient than commonly occurs when "super" is used alone. Contains a minimum of 15 per cent P_2O_5. Much used in New Zealand, where the serpentine rock occurs.
3. *Basic Slag.* A phosphatic fertilizer more suitable than superphosphate on wet sour soils and heavy soils. Must be finely ground. Usually contains 8 to 17 per cent. of phosphoric acid. Contains free lime.
4. *Steamed Bone Flour.* A phosphatic fertilizer of merit. Usually contains from 25 to 32 per cent. of phosphoric acid, and a small amount, 1 to 2 per cent. or less, of nitrogen.
5. *Bone Meal.* A material of a varying degree of fineness and of slower action than steamed bone flour. Usually contains from 3·5 to 4·5 per cent. of nitrogen and from 20 to 25 per cent. of phosphoric acid.
6. *Ground Rock Phosphate.* This mineral phosphatic fertilizer, containing from 25 to 39 per cent. of phosphoric acid as calcium phosphate has not been found to be very useful for vegetable crops.

Note that the phosphate in almost all phosphatic materials, except superphosphate, does not exist as a water soluble substance but chiefly as bicalcic or tricalcic phosphate. Also note that one unit of water-soluble

phosphoric acid is equal to 2.18 of tricalcic phosphate. Water-soluble phosphates are the most rapid in action and the most useful for vegetable crops, but a great deal depends on the type of soil and its chemical condition. Fixation and transformation takes place more or less rapidly according to the soil's condition.

Potassic Fertilizers.

1. *Muriate of Potash.* The cheapest source of potash and a valuable fertilizer for most vegetable crops. Usually of 80 per cent. purity and contains 50 or 60 per cent. pure potash. The carrier is chlorine
2. *Sulphate of Potash.* The highest grade of potassic fertilizer, averaging 92 per cent. purity and containing 48 per cent. of pure potash.
3. *Potash Salts.* A potash fertilizer of a lower grade than the preceding, contains varying proportions of common salt, sodium chloride. Two grades are usually available, one containing 20 per cent. and the other 30 per cent. of potash.
4. *Nitrate of Potash.* See under nitrogenous fertilizers and below.

Fertilizers containing two or more Plant Food Constituents.

1. *Nitrate of Potash* (see Nitrogenous Fertilizers).
2. *Peruvian Guano.* This material varies greatly in fertilizing value according to its age and source, and should always be purchased on analysis. Analyses range from 2 to 8 per cent. of nitrogen, 15 to 30 per cent. of phosphate (tricalcic form) and 2 to 4 per cent. potash. It is often offered at too high a price.
3. *Fish Guano* (Fish Manure). A valuable fertilizer derived from waste fish and other materials. The commercial product is not always uniform. Nitrogen 6 to 10 per cent.; phosphates 10 to 20 per cent.; potash variable.
4. *Meat Meal.* A product of the slaughter house varying somewhat in composition according to grade. Average analysis 6 per cent. of nitrogen and 20 per cent. of phosphates (tricalcic).

Substances to supply Trace or Minor Elements.

Boron. This element is cheaply and freely available in the form of granulated commercial borax. Normally applications of 20 lb. per acre are sufficient.

Magnesium. This element is commonly available as magnesium sulphate (Epsoms Salts). Applications of 200 lb. per acre are usually sufficient. It is also available in the form of a magnesium limestone.

Manganese. Manganese sulphate may be applied as a fertilizer dressing at the rate of 100 lb. per acre to make good a deficiency of this element.

Mixing Fertilizers at Home.

The above range of commercial fertilizers is normally available to the vegetable grower at reasonable prices. The preparation at home of a complete fertilizer, although calling

for careful calculation and skilful handling in mixing practice all can adopt, but the following points shoul observed.

(1) Safeguard financial interests by ascertaining the value of each principal ingredient, i.e., nitrogen, solub insoluble phosphate and potash. The rule is always to d the price per ton of the fertilizer by the percentage nu of plant food constituent. The resulting figure is the unit of the fertilizer.

(2) Always calculate in terms of nitrogen, soluble p phate (water-soluble or citric-acid-soluble) and pure pota

(3) Do not mix together unsuitable mater als.

The following is a safe guide :

Ammonium salts should never be mixed with lime or b slag as the lime displaces, and causes a loss of, the ammo

Nitrates should never be mixed with acid substances or nitrogen will be dispersed. Superphosphates and other mater containing soluble phosphoric acid should not be mixed materials containing free lime or reversion takes place.

These mixtures are always safe :

Superphosphate with sulphate of ammonia and sulphate muriate of potash.

Nitrate of soda with basic slag.

Nitrate of soda or sulphate of ammonia with phospha guanos or bone materials.

Fish guanos with any mineral fertilizer such as superph phate or muriate of potash.

When mixing fertilizers at home, the user should calcul the cost and add an allowance for labour of mixing, disin grating, rebagging, drying substances, etc. He should work o the composition of the type of complete fertilizer required each crop, bearing in mind the type of soil, probable cash val of the crop, and general conditions under which the fertili

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* One unit of nitrogen is equal to 1·214 of ammonia.

One unit of water-soluble phosphoric acid is equal to 2·18 of tricalcic ph phate.

One unit of potash is equal to 0·540 of sulphate of potash.

s to be used. It is more convenient to calculate in units of 100 lb. as this method saves time and gives a clearer picture of the actual amounts of plant nutrient constituents in the mixture is eventually applied to the land.

Example of a Home-prepared Complete Fertilizer Mixture :

To prepare 1,000 lb. (approximately 9 cwt.) of fertilizer possessing a 1-2-1 analysis ratio and an actual analysis of 4 per cent. nitrogen, 9 per cent. water-soluble phosphoric acid and 4 per cent. potash, the following materials may be used successfully :

Sulphate of ammonia	... 200 lb.	Total nitrogen	...	40 lb.
Superphosphate (18% P_2O_5)	500 lb.	Total P_2O_5	...	90 lb.
Potash Salts (20% potash)	200 lb.	Total potash	...	40 lb.
Filler, *e.g.*, dried sand	... 100 lb.			
Total	1,000 lb.			

As will be seen from the list given above the percentages of plant food constituents in the various substances sold as fertilizers range from 5 to 50 per cent. The calculation of the different quantities of each material required to make, say 1,000 lb. of mixed fertilizer, presents no difficulty once the grower has determined the complete analysis of the mixture he desires to produce. That is one of the advantages of working with standard commercial fertilizers.

Finally, it is well to remember that, in order to avoid caking, most home-mixed fertilizers should preferably be used within a few days of mixing and should be stored, in bags, on wood floors in a dry shed until required for application.

Lime

Lime may be applied to land in various forms, e.g. as quicklime (calcium oxide), hydrated lime (slaked quicklime), ground chalk, ground limestone (calcium carbonate), waste lime (e.g. sugar factory wastes), and cretaceous sea-beach sands. The latter are amongst the most useful forms of lime for heavy soils as the sand has an opening effect. Cornish beach sands have calcium carbonate contents ranging from 50 to 85 per cent. They are applied at rates of from 2 to 6 tons per acre. Dressings

of quicklime and hydrated lime range from 15 cwt. to 20 per acre, and ground chalk and limestone from 20 cwt 30 cwt. per acre.

Note on Composting with Manure

The compost is made in pits 28 ft. long, 14 ft. wide and 18 deep, with channels in the bottom leading to a 4 in. up ri pipe at end to act as a ventilator. Channels are covered by slabs or tiles with spaces between. Layers are built of 18 waste or straw, with 3 in. of fresh horse manure alternating, u a height of 6 ft. in reached. The heap will heat up to 160 deg It is turned at 3 weeks, throwing outsides into centre and turn again in another 3 weeks. After further 3 weeks compost ready for use. Output per pit 8-9 tons. Amount of horse manu per pit—30 cwt.

PPENDIX III.

inance and Accounts

Vegetable growing, like fruit growing and general rming, is a business, and all undertakings, whether large or nall, should be run on business lines. Implicit in this term is ne routine keeping of books and the annual preparation of a rading and Profit and Loss Account and a Balance Sheet at ne expiration of every period of 12 months' operations, so nat the operator may sum up the financial position and see ow the business stands. The annual accounts are important o every business, particularly to the various types of husbandry, where it is not only necessary to know that the capital put into he undertaking is earning a reasonable return as an investment, out also to discover the costs of crop production as reflected n money expended on wages, fertilizers, etc., together with ppropriate allowances for depreciation of machinery and the ike. It is also necessary to know the cost of marketing the roduce as distinct from the cost of production.

The operator who keeps proper books for his holding is ble to prepare without difficulty the annual Trading Account showing the *gross income* and the *gross charges* and o can arrive at the *farm income*. Using this figure he can arrive t both the net and the investment income, if there be a sufficient rofit surplus. If the business is losing money, then he can iscover the amount of the loss and act accordingly. It is in any vent important to ascertain the nature and amount of the alance figure, whether profit or loss, and book-keeping rovides the only reliable way of doing this.

The gross income represents the sum of receipts for sales of roduce and livestock together with any other earnings effected uring the year. To this is added the figure (taken by valuation)

for the unmarketed crops still on the holding at the time the annual account is prepared, together with the figure for valuation of dead and live stock. Dead stock includes all the implements, vehicles and machinery attached to the holding, and the stock of manures, seeds, packages, etc., in hand at the end of the trading year.

The gross charges comprise all expenditure concerned with growing and marketing the crops, including the wages of workers (both permanent and casual), the cost of manures, fertilizers and seeds, cost of repairs to equipment, the cost of transport (whether home maintained or hired) together with the cost of packages, packing material, etc., concerned with marketing the produce. To this is added the amount for valuation of stock (crops, dead and live stock) from the previous year's account which then figured on the income side.

The farm income, which is the amount of the difference between gross income and gross charges, is the important figure in each year's operations, for it is the amount available to meet the rent and other land charges, office expenses and the charges for redemption and interest of loans. Thus the actual net profit on the year's working is discovered, and this figure forms the basis for ascertaining both the family income, including the remuneration of the operator and any members of his family for management and labour, and the investment income, that is, the amount earned by the capital put into the business at the outset.

The examples given in this Appendix of a Trading and Profit and Loss Account and a Balance Sheet for a privately run vegetable farm or market garden are for general guidance only. The "by" and "to" items in the former are the usual ones, and the figures, which of course, are fictitious, are inserted to show how the accounts are prepared and balanced. The following brief review of book-keeping routine may be of service to those beginning business as growers.

No special experience or training is called for in keeping simple farm accounts. Three "books" are necessary, viz., the Day Book or Journal, the Cash Book and the Ledger.

The Journal, as its name implies, is a day-to-day record of all the trading transactions of the holding, including all purchases and sales on credit and particulars of all cash received and paid away. It *must* be entered up daily.

The Cash Book is kept for the final recording of all cash and bank transactions in the form of left and right hand columns, i.e. the Debtor and Creditor sides. Thus an analysis of the daily transactions recorded in the Journal is obtained by the regular posting, weekly or monthly, to the Cash Book, and at the same time a progress report on the operation of the undertaking as a business is secured.

The Ledger constitutes the final record of all the financial transactions in the form of the various accounts that will figure in the preparation of the Profit and Loss Account and the Balance Sheet at the end of the trading year. Each account (there are usually at least six) is kept on the rule of book-keeping that requires that receiving values are *debited* and payment values are *credited*, the two sides of each account being made to agree.

Some of the more important accounts in the Ledger of a farm or market garden are :—Capital Account, Wages Account, Live Stock Account, Goods or Purchases Account, Sundry Debtors and Sundry Creditors. Where much machinery, implements, vehicles, etc., are necessary to the undertaking a Machinery Account should be kept separately, showing the annual valuation of the equipment as against original cost, and the amounts allowed for depreciation, always an important matter where wear and tear and other factors operate continually. Depreciation rates on implements, machinery, etc., vary according to their type and anticipated life, the following being examples of rates usually recognised :—Motor lorries, 20 per cent; farm tractors, 22½ per cent; farm implements, 10 per cent small tools, 20 per cent. Usually the cost of replacements and any new machines or articles is added to the amount of the valuation. Thus a full record is kept of the position concerning implements and machinery, and correct figures are available for the Profit and Loss Accounts and the Balance Sheet at the end of the year.

Other accounts that appear in the Ledger are the Private Account and the Profit and Loss Account. The former is very necessary where, as should be, the operator sees that his personal financial transactions are kept part from those of the farm. Private payments and drawings for personal use tend to cause confusion, and this can be avoided by having two banking accounts—an A and B—representing the farm and personal

transactions respectively. All moneys transferred from the farm account to the personal account are accounted for in the Private and Capital Accounts of the Ledger.

The complete picture of the undertaking's financial position is obtained when the Trading and Profit and Loss Account and the Balance Sheet are prepared at the end of the trading year. The form of the Trading and Profit and Loss Account is usually simple, and if the Cash Book has been correctly posted, should present no difficulty. The Balance Sheet is prepared to give the operator an approximate (but as accurate as possible) idea of his, or rather the holding's financial position. It is, in short, an annual statement of Assets and Liabilities, the excess or otherwise of the farmer in relation to the latter providing the key to the position. It should, of course, be concerned with the farm's Assets and Liabilities only, and not the operator's personal affairs.

A last point to be dealt with in this brief review of book-keeping on the market garden relates to the type of operator known as the owner-occupier. In such circumstances the operator may be farming land purchased by means of a loan from the bank or a mortage company, and so is in a somewhat different position from a tenant operator paying an annual rent for the land to a landlord. Usually, he is committed to paying annual interest on the amount of the loan together with some amount by way of redemption. The two charges taken together will most likely come to more than a figure that might be regarded as a fair rent, and although the business usually has to find this money from its earnings it is unfair to charge these amounts to the annual Trading and Profit and Loss Account in place of a rent charge. If so done it might fairly be said that the business is saddled with the task of buying the land as it goes along in addition to paying interest on borrowed capital. To meet this position, it is the best course to open two further accounts in the Ledger—an Estate Loan Account and a Land and Building Account. These accounts are then properly posted with the Debit and Credit items, and the operator can treat these accounts separately just as if he were the landlord, as indeed he is for all practical purposes. The annual outgoings in the shape of land tax, drainage rates, tithe, repairs and interest on the loan should be recorded, together with any payments on account of principal. At the end of each trading year the

receipts and payments from the Estate Loan Account are shown in the Profit and Loss Account, but separately from the farming transactions. The freehold value of the holding is shown in the closing valuation for each year, the actual figure being posted to the Credit of the Land and Buildings Account in the Ledger and inserted as an Asset in the Balance Sheet.

As no rent is paid by owner-occupiers no figure can be inserted in the accounts in respect of this item. Growers, however, often like to arrive at a fair rental figure for the land they own and farm, to be taken into consideration when looking at the figures of the Profit and Loss Account. It also enables them to form an opinion of the advantages or otherwise accruing from ownership of land.

Capital Expenditure.

Farm Capital. The market gardener is as favourably placed for raising capital for development purposes as the farmer and fruitgrower. Funds are available through the Agricultural Mortgage Corporation Ltd. (London), at a reasonable rate of interest (3½ per cent at present), repayable over extended periods. This borrowed money may be applied to several purposes concerned with land development. Particulars are available from the Corporation at Stone House, Bishopsgate, London, E.C.2.

The capital outlay required to establish holdings for commercial horticulture depends on the type of enterprise. A holding planned for the exclusive production of vegetables on arable farming lines will not, normally, involve so much initial capital expenditure as a market garden designed for intensive production, or for early and out-of-season crops. On the basis of present prices it is estimated that the cost of equipping a holding for crop production with Dutch lights is approximately £2,000 per care, and with cloches, £1,000 per acre, both irrespective of land costs.

Land prices have risen steeply during the last 10 years, and are now approximately treble those ruling in 1938, when it was possible to purchase land suitable for both market gardening and fruit growing at prices ranging from £20 to £30 per acre, provided it was not situated in a favoured area. Owing to the housing shortage which now exists, land carrying a house in

habitable condition sells for a higher price than land with no house, and in working out figures for the actual land charges, i.e. overheads, it is reasonable, under present conditions, to deduct a fair amount for any house that goes with the land. For example, a property consisting of 100 acres of land, buildings and a good house might be acquired at say a price of £8,000, that is, £80 an acre. It would be reasonable to treat such expenditure as follows:—

Land ..	£5,000 (cropping)
Capital ..	£3,000 (housing)

This would result in reducing considerably the overhead land charges per acre, an important item in crop production costs. Land costs of between £50 and £60 per acre cannot be rated high at present values, and the probability is that even higher prices may have to be paid for land particularly suitable for market gardening on intensive lines, e.g. Dutch light and cloche cropping systems. Up to £100 per acre may be asked for land of average quality, depending on situation, water supply, approach roads, and so on.

The cost of land does not necesssarily involve a reduction in capital available for its development, for such further expenditure can, if desired, be covered by a mortgage. Money for land development may usually be obtained on the security of land from banks, through a solicitor or from the Agricultural Mortgage Corporation, and is repayable over a set period of years. The interest on money for land development is as low as 3½% (Agricultural Mortgage Corporation), hence the actual annual overhead charges on land purchased at a price as high as £100 per acre should not exceed £3 10s. 0d. or £4 per acre, which represents a very fair figure for productive land considered in terms of annual rent.

Naturally, a fairly large amount of capital must be expended to bring the land into the condition of a well-equipped market garden capable of earning a satisfactory profit. Usually, the additional expenditure is required for levelling the land, removing trees and hedges, filling in ditches and the making of roadways. Further capital expenditure is for tools and cultivating machinery, and also irrigation equipment if required. Roughly speaking, the original expenditure on land purchase may be doubled in developing and equipping the holding to the

condition of a well-equipped market garden, *not* allowing for any special expenditure such as an outlay on Dutch lights or glasshouses, though it might reasonably include sheds for packing, fertilizers, storage, etc.

Tractors suitable for market gardens range in cost from about £150 to £300, so that, including the necessary cultivating equipment, drills, etc., from £300 to £500 may account for tractor machinery in capital expenditure.

Although desirable, it is not necessary to purchase land for market garden holdings. Suitable land may often be occupied on favourable terms as to lease at rentals ranging from £3 to £5 per acre, but higher rents will be asked in the favoured districts such as Cornwall and the Vale of Evesham.

The provision of a reasonable amount of working capital should not be overlooked. For vegetable production the amount required should be sufficient to meet outgoings on account of wages, manures, fertilizers, seeds, etc., for a period of 12 months. Naturally, the capital expenditure on market garden holdings is correlated with the expected returns from the land, for care must be taken to ensure that the holding is not over-capitalised, that is, not unduly burdened with over-head charges. It must be capable of earning sufficient gross profit to show a fair interest on expended capital and leave a net profit to provide the operator's income.

Unlike the arrangements made for agricultural produce (see Agriculture Act 1947), no system of price guarantee has been devised for horticultural produce, though the prices of some produce, carrots for example, are still controlled by war-time regulations.

The gross returns for crops on arable farming holdings may be estimated fairly accurately and thus the farmer is able to operate on a costings basis to ensure a reasonable profit. Horticultural holdings, on the other hand, supply produce to an unpredictable market, and one that is subject to the effect of seasonal glutting and other factors such as a demand influenced by weather conditions, e.g. cold weather and salad crops. As a basis of calculation, however, it might be reckoned that the receipts for ordinary market garden crops will average between £60 and £100 an acre under present conditions of supply and demand and taking one crop with another throughout the year. Individual crops, of course, will often realise very

much more; on the other hand crops, on occasion, may encounter a heavily supplied market with resulting low prices, and may even be in the category of the "unwanted."

It is always important to know the cost of *growing* a crop as well as the cost of *marketing* it, so that economies and adjustments may be made when necessary. For example, figures for growing and marketing onions during the 1939-40 decade, recorded by the author, were as follows—per acre:—

	£	s	d.
Land Charge	1	10	0
Ploughing and Cultivating	1	0	0
Plants (cost of raising)	6	7	6
Plants (transplanting)	6	8	0
Fertilizers and application	6	3	6
Cleaning (hoeing, etc.)	4	15	0
Harvesting the crop	4	5	0
TOTAL COST OF CROP ...	£30	9	0

Final figures for the crop were as follows:—

	£	s.	d.
Cost of production	30	9	0
Cost of marketing	4	17	0
TOTAL COSTS ...	£35	6	0
Value of crop grown per acre	76	11	0
LESS production and marketing costs ...	35	6	0
BALANCE	£41	5	0

N.B. The crop yield was 11 tons 14 cwt. per acre and the price realised was 6s. 6d. per cwt. Although the selling value of the crop was low, the crop profit was satisfactory.

Trading and Profit and Loss Account for Rose Hall Farm, January 1st to December 31st, 1945.

1945			£ s. d.
Jan. 1st.	To Stock at opening Valuation		
	Crops and Dead Stock ...		1,041 9 8
	Live Stock		67 0 0
Dec. 31st	To Wages and Insurance ...		1,737 19 10
	Casual Wages		167 16 4
	Purchases :		
	Seeds, Plants, etc.	490 10 0	
	Manures, etc. ...	350 8 6	
	Packages, etc. ...	54 8 10	
	Food for Live Stock	186 18 0	
	Food for Horses ...	65 10 0	
	Petrol, Oil, etc. ...	75 18 8	
			1,221 14 0
	To Repairs of Implements ...		76 2 6
	Hire of Implements ...		26 10 0
	Transport		347 12 6
	Rent, Rates, etc.		450 10 0
	Gross Profit brought down ...		1,897 13 1
			£7,034 7 11
	To Office Expenses		62 10 0
	Sundry Creditors		48 6 0
	Depreciation Office Equipment		5 0 0
	Net Profit		1,840 7 1
			£1,956 3 1

1945			£ s. d.
Dec. 31st	By Sales of Produce		
	Potatoes ...	1,464 0 0	
	Cabbage	834 5 0	
	Peas	582 3 3	
	Asparagus ...	281 10 0	
	Lettuce, etc. ...	203 8 11	
	Beans, Runner ...	450 9 0	
	Beans, Broad ...	124 12 10	
	Beans, French ...	160 4 0	
	Brussels Sprouts ...	578 9 10	
	Sundry Green Crops	360 10 1	
	Cauliflower and Broccoli ...	440 8 0	
	Miscellaneous Crops	60 10 6	
			5,540 11 5
	By Sales of Live Stock		260 12 0
	Hire of Implements ...		36 0 0
	Sale of Hay and Clover ...		140 14 0
	Stock at Closing Valuation :		
	Crops and Dead Stock ...		960 10 6
	Live Stock		96 0 0
			£7,034 7 11
	By Gross Profit from Trading Account		1,897 13 1
	To Sundry Debtors		58 10 0
			£1,956 3 1

1946		
Jan. 1st	To Valuation at date brought down	£1,056 10 6

Balance Sheet of Rose Hall Farm as at December 31st, 1945.

Liabilities:	£	s.	d.	Assets:	£	s.	d.
Sundry Creditors	48	6	0	Cash in hand	50	0	0
Capital at this date	2,168	15	0	Cash at bank	965	10	0
				Sundry Debtors	58	10	0
				Valuation of			
				Crops and Dead Stock	960	10	6
				Live Stock	96	0	0
				Valuation of Office Equipment	86	10	6
	£2,217	1	0		£2,217	1	0

1946 Jan. 1st	To Capital Account	£2,168	15	0

Books on special subjects recommended for further reading.

The Soil.

Soil Physics by L. D. Baver, John Wiley and Sons, New York, Chapman and Hall, London, 1940.

The Scientific Study of the Soil by Norman M. Comber. Ed. Arnold & Co. London, 3rd Ed. 1936, reprinted 1943.

Humus: Origin, Chemical Composition and Importance in Nature, by Solman A. Waksman, 2nd Ed., Balliere, Tindall and Cox, London, 1940.

The Plant.

The Genetics of Garden Plants by M. B. Crane and W. J. C. Lawrence, Macmillan & Co., London, 3rd Ed., 1947.

Practical Plant Breeding by W. J. C. Lawrence, Allen and Unwin Ltd., London, 2nd Ed., 1939, reprinted 1945.

pH and Plants by James Small, Balliere, Tindall and Cox, London, 1946.

Hunger Signs in Crops, 14 authors. The American Society of Agronomy and The National Fertilizer Association, Washington D.C., 1941.

The Diagnosis of Mineral Deficiencies in Plants, by T. Wallace, H.M. Stationery Office, London, 1943.
Ditto (Supplement), 1944.

APPENDIX IV

Standard list of Vegetabl

(As approved by the Seed Production Committe

PEA (*Pisum sativum*)
Round-seed Varieties
- British Lion
- Early Bird
- Foremost
- Meteor
- Pilot
- Superb
- Alaska (for the canning trade)

Wrinkled varieties
- Alderman
- Duplex
- English Wonder
- Giant Stride
- Gradus
- Kelevedon Wonder
- Lancashire Lad
- Lincoln
- Little Marvel
- Lord Chancellor
- Miracle (Sharpe's)
- Onward
- Pioneer
- Progress
- Senator
- Thomas Laxton
- Canner's Perfection (for the canning trade)
- Delicatesse do.
- Surprise do.

BROAD BEANS (*Vicia Faba*)
Longpods
- Early
- Johnson's Wonderful
- Bunyard's Exhibition
- Masterpiece Green (for the canning trade)
- Threefold White

Windsors
- Four-seeded White
- Four-seeded Green
- (The Harlington types if Fou seeded not available)

RUNNER BEAN (*Phaseolus multiflor*
- Princeps
- Prizewinner
- Scarlet Emperor types
- Scarlet Ordinary

DWARF BEAN (*Phaseolus vulgaris*)
- Black Prince
- Brown Dutch
- Canadian Wonder
- Comtesse de Chambord
- Masterpiece
- The Prince
- Keeney's Refugee Stringless Greenpod (for the canning trade)

BEET (*Beta vulgaris*)
Long and Intermediate Varieties.
- Cheltenham Green Top
- Nutting's Red
- Intermediate or Obelisk (Nonpariel)

Round Varieties
- Red Globe (Detroit Dark Red)
- Crimson Globe
- Beet, Green or Spinach

BORECOLE OR KALE (*Brassica oleracea* var. *acephala*)
- Cottager's
- Dwarf Green Curled
- Tall Green Curled
- Hungry Gap
- Marrow Stem Green
- Thousand Headed

BROCCOLI (*Brassica oleracea* var *botrytis*)
Late Queen
Leamington
Lenten Monarch
June (Clucas)
June (Methven)
Purple Sprouting Early
Purple Sprouting Late
Roscoff Varieties
Snow's Winter
St. George (Clucas)
White Sprouting Early

BRUSSELS SPROUT (*Brassica oleracea* var. *gemmifera*)
XXX (Harrison)
Evesham types
The Wroxton
Cambridge Nos. 1, 3 and 5
(Also Rous Lench as an early variety if desired)

CABBAGE (*Brassica oleracea* var. *capitata*)
Pointed varieties
Ellam's Early
Enfield Market
First and Best
Leeds Market
Offenham
Wheeler's Imperial
Winnigstadt
McEwan types

Drumhead and Round Varieties
Brunswick
Christmas
January King
Primo
Red Drumhead
Robinson's Champion

CARROT (*Daucus carota*)
Chantenay type
Early Nantes
James' Scarlet Intermediate
St. Valery

CAULIFLOWER (*Brassica oleracea* var. *botrytis*)
All the Year Round
Majestic
Snowball
Veitch's Autumn Giant and self-protecting types

CELERY (*Apium graveolens* var. *dulce*)
Clayworth Prize Pink
Standard Bearer Red
Wright's Giant White

CRESS (*Lepidium sativum*)
Plain

CUCUMBER (*Cucumis sativus*)
Ridge varieties
Gherkin
Long Green

LEEK (*Allium porrum*)
Musselburgh or any standard varieties

LETTUCE (*Lactuca sativa*)

Cabbage Varieties
All the Year Round
Arctic King types
Cheshunt Early Giant
Feltham King
Iceberg
May King
New York or Wonderful
Tom Thumb
Trocadero Improved Green

Cos Varieties
Density
Lobjoit's Green
Paris White

MUSTARD (*Brassica alba*)
White

ONION (*Allium cepa*)
Ailsa Craig
Bedfordshire Champion
James' Longkeeping
Up-to-date
White Lisbon or similar
White Spanish or similar

PARSLEY (*Carum petroselinum*)
Curled

PARSNIP (*Pastinaca sativa*)
Hollow Crown
Offenham

RADISH (*Raphanus sativus*)
Round varieties
Scarlet Globe
Sparkler

Long and Half Long Varieties
Woods' Early Frame
French Breakfast

SAVOY (*Brassica oleracea* var. *capitata*)
Best of All
Ormskirk types

SPINACH (*Spinacia oleracea*)
and vars.
King of Denmark
Longstanding Giant Prickly
Longstanding Giant Round

TOMATO (*Lycopersicon esculentum*)
It is difficult to standardize varieties

TURNIP, GARDEN (*Brassica rapa*)
Golden Ball or Stone
Manchester Market
Milan White
Purple Top Milan
Snowball

SWEDE, GARDEN (*Brassica rapa*)
Laing's

VEGETABLE MARROW (*Lagenaria*)
Bush Green Bush White
Long Green Long White

Index

Artichokes, Globe, 224
  fertilizers for, 225
  varieties of, 225
Artichokes, Jerusalem, 186
  fertilizers for, 186
Artificial fertilizers, 56, 58
Asparagus, 220
  growing seed of, 224
  manuring of, 222
  soils for, 220
  varieties of, 221

Basic Slag, 314
Biggleswade district, 42
Bone Meal, 314
Bordeaux Mixture, 306
Brassica crops, 117
  growing seed of, 86, 102
Beans, Broad, 158
Beans, Kidney or French, 153
  for canning, or drying, 156
Beans, Runner, 151
Broccoli, 119
  fertilizers for, 122
  manuring of, 122
  types of, 120
Brussels Sprouts, 112
  comparative cost of production of, 118
  fertilizers for, 117
  soils for, 115
  types of, 112
Bulb Crops, 187

Cabbages, 131
  classes and varieties of, 131
  manuring of, 132
Cabbage Greens, 134
  fertilizers for, 135
Calabrese, 137
Calcium cyanamide, 313
Canning, 33
Caraway, 279
Carrots, 160
  growing seed of, 165
  in Dutch frames, 253
  manuring of, 163
  types of, 160, 161

Cauliflowers, 124
  early summer types of, 124
  fertilizers for, 125
  for pickling, 129
  in Dutch frames, 253
  late summer and autumn types of, 127
  summer types of, 126
  with Evesham hand-lights, 257
Celery, 226
  growing seed of, 233
  manuring of, 230
  raising plants of, 228
  self blanching, 232
  soils for, 228
  types and varieties of, 226
Celeriac, 226
Chicory, 267
  salad, 216
  Witloof, 267
    forcing of, 268
    growing roots of, 267
Coffee Chicory, 172
Climate, 51
Cloches, 258
  Evesham type, 257
  continuous, 258
Composting, 53, 318
Containers for market produce, 310
Corn Cobs (See Sweet Corn)
Crop cultivation, 75
Cropping,
  system of, 81
Cucumbers, Ridge, 213
  manuring of, 214
  varieties of, 214
Culinary Herbs, 273

Dehydration, 36
Diseases of Vegetable Crops, 282, 300
Dried Blood, 314
Dutch frames, 252

Early and Forced Crops, 249
Eastern Area, 43
  production in the, 43
Elements of plant nutrition—
  major, 59
  trace, 59

Radish, 316
  fertilizers for, 316
  varieties of, 317
Receiving stations, 49
  hand-light, 241

Rhizomes and tubers, 90
Rotations—
  general, 90
  for vegetable crops, 91, 92
  high analysis, 88
  making of, at home, 88, 413
  need of, 91
  rotation of, 416
Rue Cousin, 213
Russet vegetables, 362
Rutaceae, Family, 242
  French, 243
  Russet, 244
  problems of Europe, 245, 246
Rutabaga, 34
Rutaceae or Citrus fruits, 243
  Russet crops of, 243, 244
  growing seed of, 186
  manuring of, 184
  varieties of, 184
Ryegrass, 413

Sachet, 185
Sachetum, 213
Sacking and Packing, 390
Saint Cloud (See Cloud)
Saint Rock Phosphate, 414

Sand light (See Brisham hand light)
Sand Seedlings, 165
Sand's Cultivator—
  production in this, 41
Sand and Farm Meal, 414
Sauce, 79
Sauce-radish, 378

Saws and Animal Pests—
  of seeds, 96
  of vegetable crops, 387, 388, 391
Scarlet ants, 392
Sclerotium, 82, 86

John Innes compost, 166

Kale, 145
  fertilizers for, 146
  varieties of, 146
Kohl-rabi, 175

Leeks, 196
  manuring of, 197
  varieties of, 196
Leguminous crops, 90
Lettuce, cultivation—
  types and varieties of, 301

Lettuce, cultivation—
  types and varieties of, 302
Lettuce, cultivation crops, 296
  growing seed of, 304
  in Dutch frames, 299
  in glasshouses, 301
  in hotbed frames, 299
  manuring of, 304
  soils for, 303
Lime, use of, 68

Manure—
  farmyard and stables, 80
  plant nutrient value of, 64
  production of by animals, 63, 64
Manurial Treatment, 87
Meat Meal, 413
Mechanical treatment, 173
Mendelism, 87, 93
Mint, 278
  growing of, 280
  medicinal crops of, 279
Mixture of Breeds, 413
Mushrooms, 243
  making beds for, 243
  manure for, 243
  spawn, 243
Mustard and Cress, 212

National Advisory Service, 60
Nitrate of Soda, 414
Nitrate of potash, 414
Nitro-chalk, 414
Northern Area, 44
North- and West-Midland Area, 49

Onions, 187
  common sorts, 189
    manuring of, 191
    varieties of, 191
  for pickling, 189
    varieties of, 191
  from Sets, 192
  green or salad, 212
  growing seed of, 190
  sets production of, 194
  spring sorts, 188
    manuring of, 189
    varieties of, 189, 190

Parsley, 274
Parsnips, 160
  manuring of, 160
  varieties of, 160
Peas, 141
  manuring of, 144
  seed growing, 140
  soils for, 142
  varieties of, 141
Peruvian Guano, 415
Pests and Diseases of Vegetable Crops, 387

Pickling, 35
Plant-Breeding in relation to Vegetable Crops, 88
Plants,
  moving of, 102, 106, 108
  transplanting of, 103, 105
Ploughing, 73
Potash Salts, 315
Potato, 178
  varieties of, 178
  cultivation of maincrops, 180
  cultivation of early crops, 184
  sweet,
Pumpkin, 239

Radishes—
  summer, 218
  in Dutch frames, 253
  in glasshouses, 251
  winter, 219
Raw elements of growth, 59
Red Beet, 170
  fertilizers for, 170
  growing seed of, 171
  varieties of, 170
Red Cabbage, 136
  fertilizers for, 137
  varieties of, 136
Rhubarb, outdoor, 234
  fertilizers for, 236
  forced, 262
  varieties of, 234
Root Crops, 160

Sage, 276
Salsify, 172
Savoy Cabbages, 131
Seakale, 265
  forcing of, 266
  growing roots of, 266
Seed bed preparation, 74
Seed-borne diseases, 97
Seeds—
  characteristics of vegetable, 86
  distribution of, 99
  germination and purity of, 95
  germination energy of, 96
  improvement of vegetable crop, 93
  longevity of, 96
  production of vegetable, 86
  sale of, 100
  sowing, 100
Shallots, 198
Shoddy, 314
Soil heating, 249
Soil moisture, 78
Soot, 313
South-Western Area— 42
Southern Area—
  production in the, 41
Spinach, 239
  fertilizers for, 240
  types and varieties of, 240
  growing seed of, 241
Spinach Beet, 242
Spinach, New Zealand, 242
Spraying—
  to control weeds, 83
  to control disease, 302
Sprouting Broccoli, 137
Squash, 239
Storage, 311
Steamed Bone Flour, 314
Sulphate of Ammonia, 313
Sulphate of Potash, 315
Superphosphate, 314
Swedes, 166
Sweet Corn, 246
Swiss Chard, 242

Thyme, 278
Tillage, 69
  implements used for, 69
  mechanized, 69
Tomatoes, outdoor, 257
  manuring, 258
  saving seed of, 259
  varieties of, 257
Tractors, 69
Turnips, 166
  fertilizers for, 167
  growing seed of, 168
  in Dutch frames, 253
  varieties of, 167
Turnip-tops, 168

Vegetable Crops—
  acreages and tonnages of production for 1930-32 period, 38
  acreages of, for 8-year period, 45
  areas of production of, 41
  breeding of, 88
  containers for, 310
  distribution of, 31
  economic aspect of, 37
  effect of climatic conditions on, 51
  food value of, 17
  material treatment of, 57
  soils for, 47
  survey of production of, 26
  systems of production of, 29
  systems of irrigation for, 52
  transport of, 37
  wholesale prices for 10-year period of, 46

Vegetable growing industry, status of, 17, 26
Vegetable Marrows, 237
forced crops of, 252
growing seed of, 239
manuring of, 237
varieties of, 237

Watercress, 210
construction of beds for, 210
propagation of, 210
Weeds—
control of by spraying, 83
control of by burning, 85

Virus diseases, 281

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169.	5/12/59	5/12
245.	3.1.60	4/1
141	4/3	4/3
181.	30/9	26/9/62.
272	26/10/62	26/10/62.
350	26/11/62	23/11/62
6.	29/1	29/1/63.
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